Nature

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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—Wordsworth

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, NOVEMBER 3, 1898.

ANALYTICAL CHEMISTRY.

A Manual of Chemical Analysis, Qualitative and Quantitative. By G. S. Newth. Pp. 462. (London: Longmans, Green, and Co., 1898.)

A Laboratory Guide in Qualitative Chemical Analysis. By H. L. Wells, M.A. Pp. 180. (New York: Wiley and Sons. London: Chapman and Hall, Ltd., 1898.)

A Short Course in Inorganic Qualitative Analysis. By J. S. C. Wells, Ph.D. (New York: Wiley and Sons. London: Chapman and Hall, Ltd., 1898.)

IT is now becoming generally recognised that chemical analysis is a subject that may be looked at, taught, and practised in two ways—as an art, or as a science. No doubt it should be both, and always has been both with chemists properly so-called; but it is sad to think of the time, trouble and money that have been expended during the last thirty years in disseminating a smattering of the analytical art on the supposition that education and even British industry would be thereby furthered.

The demand for a practical chemistry that could be easily scheduled, that should not be too elaborate, and that could be examined and controlled by sending out packets of powders and getting back packets of papers, has contributed, doubtless, more than anything else to the degradation of chemical analysis. At the same time it must be admitted that chemical analysis as a science suffered seriously by the abolition of the ideas and notation of the dualistic theory. Before then the current names and formulae were at least consistent, and the writing of equations could be conducted on comparatively simple general principles. Even now there are probably few chemists who would calculate the oxidising value of potassium permanganate in reference to ferrous sulphate, otherwise than by dualistic conceptions and formulae. The hopeless confusion arising over the old terms *acid*, *base* and *salt*, and especially *basic salt*, in their modern use, must be known to every teacher.

To those who in recent years have protested against chemical analysis as an introduction to practical science it has been objected that analysis, when properly taught, is a highly educative subject. But this has never been disputed; the point is that analysis is far too high a science and too difficult an art for young boys, and that a little proficiency in the art of "taking a solution through the chart" has, practically speaking, been the only attainable outcome of a positive kind, whilst the habits of mind and manipulation usually engendered have been lamentable.

The tide is happily with the reformers, and the improvement that has taken place within the last ten years in school science is one of the most remarkable and gratifying of the numerous signs now evident that a more rational and humane spirit is pervading British education.

For those who wish to make a serious study of chemistry, chemical analysis has still to be taught, and how to teach it best, is a question which may perplex the most thoughtful teacher. The fundamental difficulty is that there appears to be no thin end to the wedge. If the subject is to be taught scientifically—that is to say, if the reactions on which analysis is based are to be elucidated as they arise—the student is at once thrust into a thicket of ramifying facts in which he will find his way with difficulty. Suppose he begin with the reactions of the silver group, he is at once among the mercuramines; should he begin at the other end, there are the platinichlorides and acid tartrates. The student, in fact, who is to learn analysis scientifically at the first attempt, requires a fair knowledge of chemistry to begin with. The choice lies between devising some extended practical work, beyond the mere preparation of gases, as a preliminary to analysis, or making the student, as he might put it, "do analysis" more than once. In the last case, the analytical operations are not comprehended to their inmost parts in first traversing the course, but a preliminary survey is obtained, and the student learns something, at least, about a great many substances and reactions. It is, after all, something to know the mere outside of things in chemistry. The difficulty, however, is to secure the *da capo* or cud-chewing process which is essential to the success of this scheme. It is not easy to convince the half-informed of

their ignorance. No doubt, the best way to approach analysis is through preliminary practical work in which typical substances are prepared by typical reactions, and subjected to a careful qualitative and quantitative study; but no one has yet given a really good lead in this direction, though several books of inorganic preparations have appeared in recent years.

Sooner or later the serious student of chemistry must enter upon the systematic study of analysis, and the selection of a good handbook becomes an important matter. It has been the habit for writers on analysis to confine themselves almost entirely to the technique of the subject, and among the scores of books written a fair number might be named as trustworthy guides in the processes of qualitative and quantitative analysis. At the head of these stands the well-known work of Fresenius—a monument of industry and care. It must be recognised, however, that Fresenius' book is essentially an analytical dictionary. If it be an object in the teaching of analysis—and it is surely, for the general student, the chief object—to make the learner familiar with the philosophy of the subject, the use of Fresenius and the smaller versions of Fresenius must be supplemented by something else, either in the way of oral teaching or literature. The circumstances of few laboratories permit of the constant personal supervision which is necessary to keep an analytical student straight on the theoretical side of his work, and thus the possession of a book which really grapples with the chemistry of analytical reactions becomes indispensable. It is, however, only recently that a book adequately fulfilling this purpose has appeared in the English language, though a little-known manual published by the late Prof. Dittmar, in 1876, deserves respectful mention. In Germany (and doubtless in Russia) for many years Menschutkin's book has occupied the place in question. Menschutkin does not pretend to be an exhaustive compendium of analytical processes; it contains no tables; it lays down no laws for the treatment of a solution containing a limited number of acids or bases; yet Menschutkin has the stamp of individuality and real science, which make it not unworthy of companionship with Mendélejeff's Principles. It was the only book on analysis which Bunsen, who had a horror of the analytical "Bradshaw," would allow to appear in his laboratory. It is to be hoped that through its English translation the book has become better known in this country.

One more type of work on analysis, and only one, can be mentioned. Ostwald's "Scientific Foundations of Analytical Chemistry" is a book *sui generis*. The view taken of this book will depend entirely on whether the reader finds the preamble proven. If the ionic theory of solution be accepted, there can be no doubt of the remarkable coherence and symmetry of Prof. Ostwald's adaptation of it to the facts and processes of analysis. The book is well worth the attention of any one who may have lightly taken up a mere prejudice against the ionic theory.

Of the books at present before us, two are of considerable interest as being out of the common style. Mr. Newth, who is well known as the author of a book of lecture experiments, and one on inorganic chemistry, both characterised by many excellent features, has now produced a manual of analysis which is no less satisfactory. It is written much in the style of Menschutkin, that is to say, it is thoroughly explanatory. At the same time there is no lack of plain practical directions for the conduct of analytical work. The book gives evidence throughout of having been written by a skilled analyst and a thoughtful chemist, whilst the frequent asides—sometimes beseeching, sometimes scornful—show that the author has tasted the sorrows of a teacher of analysis. Beginning with a chapter of preliminary manipulative exercises, the book proceeds to detail and explain the reactions of the metals in the order of the analytical groups. Two chapters follow on the conduct of a qualitative analysis and the statement of results. The second part of the book deals with quantitative analysis, including electrolytic analysis, gas analysis and organic analysis, concluding with a section on miscellaneous physico-chemical determinations. This brief summary of contents will, of course, give little idea of the real character of the book, yet it is impossible to enter minutely into either explanation or criticism of a work so full of details. The least satisfactory part is the first chapter dealing with the important matter of manipulation. In the first place it must be remarked that the essentials of manipulation should have been learned long before the systematic study of analysis is commenced, and a student who is at all ready to enter upon the second chapter of Mr. Newth's book will very probably resent the instruction to mix hydrochloric acid and charcoal in order to see how the charcoal may be filtered off and washed. Such elementary instructions are doubtless useful in their place; but their juxtaposition with chapters on systematic analysis only tends to confirm the practice of plunging students of practical chemistry prematurely into analytical work. It would at least have been better if this intention had been disclaimed. The instructions themselves also call for some comment. No recommendation is made of the filter-pump for qualitative analysis, an omission which, in the opinion of the present writer, is very regrettable. It is true that in the hands of a careless and uncontrolled student a vigorous filter-pump is a source of moral degradation, but, in other hands, it is, with limited exhaustion, perhaps the chief aid to dispatch, neatness, and even accuracy. The instructions given by Mr. Newth for evaporation, neutralisation, the use of borax beads, and the removal of precipitates seem to show that many of Bunsen's helpful artifices are still unknown in England. Other useful things which do not seem to be described by Mr. Newth, are the Gooch crucible and the perforated disc porcelain funnel. The writer would also here recommend the process of separating barium, strontium and calcium by means of nitric acid, described by Dr. S. G. Rawson in the number of the *Journal* of the Society of Chemical Industry for last February.

An addition that may well be made to a future edition is a plain statement about the rational use of figures in quantitative analysis. It is astonishing how little attention is paid by chemists to the significance of figures in the statement of an analytical result, and how seldom students are taught to let their recorded numbers bear a

proper relation to the accuracy attainable, even with perfect manipulation, in any given process. It is the commonest thing to find a pretension to accuracy of 1 part in 1000 where 1 in 50 would hardly be justified.

Mr. Newth does not introduce the ionic theory into his explanations of analytical reactions. It is not difficult to understand reluctance to embrace a theory which is still young and still the object of adverse criticism. At the same time it seems a great pity that a writer on analysis should leave the student in ignorance of what, according to a large number of eminent chemists, is the real key to the chemistry of analysis. The ionic theory need not have been woven into the fabric of the book; but it, at least, deserved a chapter and a fair hearing.

Whilst a few defects are to be noticed in the book, it is right to add that the merits are much more conspicuous; and it may be said, on the whole, that Mr. Newth's account of analysis is wide in scope, exact in detail, and particularly luminous in exposition. If it is used conscientiously by duly prepared students, it will teach them a great deal of chemistry.

Prof. Wells's book is written on somewhat different lines, yet is characterised, like Mr. Newth's, by the attention paid to the explanation rather than the mere description of reactions. Prof. Wells, who has charge of the teaching of analytical chemistry and metallurgy in the Sheffield Scientific School of the Yale University, is evidently deeply impressed with the feeling that students tend to do their analytical work in a mechanical way, taking merely marching orders from their text-books. Instead, therefore, of telling the student anything about the metallic chlorides, the author contrives that the facts shall be *discovered* by such instructions as:

"Find by experiment which of the twenty-seven solutions give precipitates when a few drops of hydrochloric acid, HCl, are added to 1 or 2 cc. in a test-tube. Write the equations of the reactions and remember the facts observed in this experiment as well as in those that follow. Why are no precipitates produced in the solutions containing chlorides?"

The directions continue in the same strain. It must be observed that the student does not proceed on a natural voyage of discovery. At every port he opens another sealed order, and takes the directed course wherever it may lead. The value of this method of teaching analysis is open to serious doubt. The student is asked to perform twenty-seven experiments, of which all but three are, practically speaking, blanks. The present writer's experience is that operations of this kind pall intolerably upon a self-respecting student. We surely have here a case where a wrong sacrifice is made to pedagogic theory. In the early stages of education it is no doubt hardly possible to pay too much attention to method. Whilst habits of mind are being formed, and pupils are young and docile, much may be permitted in the name of method; but a period arrives when the leading strings must be relaxed. As soon as a system of teaching is felt by the pupil to be a system, it is apt to lose its value, and to engender the resentment which every one feels on discovering that he is being manoeuvred. The present writer has had experience of the unintelligent student of practical chemistry, and has tried Prof. Wells's device, among others. The result has not been at all encouraging. The fact is, that by the time a student is fit to begin the study of analytical chemistry he should be fit to avail himself of straightforward explanations. If he is not fit, strategy will do but little to mend matters. Prof. Wells, however, thinks differently after fourteen years' teaching and it may be that things are different in America.

Whilst offering this general criticism of Prof. Wells's system, it is right to add that the book is wholly good in its scientific tendency, and that it contains abundant evidence of the writer's experience and grasp of analytical chemistry. The injunction that the student is to construct his own tables of separations is much to be commended. The second part of the book deals with theory; it embraces the ionic theory, and explains the phenomena of analysis from that point of view. The explanations are, it is to be feared, too brief and sketchy to be of much use. They have a somewhat high-sounding logical form, but do not always convey much substance.

"There is a direct connection between the formation of precipitates and insolubility. A compound which is readily soluble in the liquid that is present *cannot* form a precipitate in the presence of a sufficient amount of that liquid."

This surely was unnecessary.

The chapter on equations is clear and useful. The third part of the book gives an account of the properties of the inorganic radicals in alphabetical order, and does not purport to be more than a condensation of Fresenius. It contains a summarised statement of what the student is meant to have learned for himself by working through Part i.

Two "appendixes" to the book, consisting of eighteen pages of labels, seem very unnecessary.

The third book before us is also of American origin. It is intended for engineering students, though there is no evidence of this special destination in the text. In so far as the reactions are explained with fair completeness, it is in advance of the customary analysis book. The distinctive feature is to be found in a number of large tables plotting an outline of reactions which occur in the separation of the members of a group. By reference to the tables it is possible to see what is the maximum number of substances in any particular precipitate or filtrate. Thus precipitate 35 may contain $BaCO_3$, $SrCO_3$, $CaCO_3$, whilst filtrate 35 may contain $MgCl_2$ NH_4Cl, $NaCl$, KCl, $BaCl_2$ and $CaCl_2$ in traces, NH_4OH, $(NH_4)_2CO_3$. The author states that these tables have been found of much benefit to the student.

In the beginning of the book we find the statement that "in inorganic chemistry the bases comprise the metals, and the acids the non-metallic elements (with a few exceptions)"; a little later—"all acids contain hydrogen, which hydrogen is replaceable by a base"; and lastly—"bases have properties just the reverse of acids. Among the inorganic compounds they usually consist of hydroxyl in combination with a metal. Their chief characteristic is their power of uniting with acids to form neutral compounds." Could any better justification be found for the remark, made early in this article in reference to the dire effects of lingering dualistic terminology?

ARTHUR SMITHELLS.

RESEARCHES ON MEDUSAE.

The Cubomedusae. By Franklin Story Conant. (Memoirs from the Biological Laboratory of the Johns Hopkins University, vol. iv. No. 1.) Pp. xvi + 61, and plates. (Baltimore: Johns Hopkins Press, 1898.)

IT is one of the characteristics of some of the more important American Universities that they advance knowledge, employ the best of their young graduates, and at the same time add to the treasures of their museums by equipping expeditions to explore unknown regions, both of sea and land. In this way the archaeology, ethnology, geology, palaeontology, and marine zoology of Central and North America have all benefited largely; and the results of these College expeditions are to be seen in several of the Transatlantic Museums and Universities.

Last year (1897) was unfortunately most disastrous to the marine biological expeditions of two of the leading American Universities: Columbia at New York, and the Johns Hopkins at Baltimore. The Columbia University Expedition to Alaska was wrecked on the return voyage by running on the West Devil rock in Dixon entrance, the steamer sinking almost at once in deep water, and the party barely escaping with their lives (one of them, young Mr. B. B. Griffin, has unfortunately died since), while all their collections, notes, drawings, theses, and other property were lost. The Johns Hopkins Expedition to Port Antonio, in Jamaica, had even a more tragic termination. Prof. Humphrey, the leader of the expedition, died of yellow fever after a few hours' illness the day (August 17) they were to have sailed for home. Dr. Conant, the second in command, and Dr. Clark considered it their duty, under the circumstances, not to leave. Clark was then taken ill and recovered; but when they eventually sailed from Port Antonio, on September 6, Conant became ill on the second day at sea, and died on September 13 in Boston.

The present volume consists of Dr. Conant's researches on the Cubomedusae completed, and accepted by the Johns Hopkins University as a dissertation for the degree of Doctor of Philosophy, just before the author sailed on the fatal expedition to Port Antonio, and now published as a memorial by his friends, fellow-students and instructors at the University. Dr. Conant had been with the Johns Hopkins marine laboratory party at Jamaica in June 1896, and the discovery then of two new species of Cubomedusae in Kingston Harbour led him to the further study of the group. Cubomedusae are comparatively rare jelly-fish, and are of morphological interest because of the relatively high degree of development attained by their nervous system and sense-organs. After a systematic review of the position of his new species (one of them the type of a new family), Dr. Conant gives an excellent account of the anatomy and histology, with a specially full description of the nervous system and of the highly-developed eyes and associated sense-organs. Eight clearly drawn plates, nearly all the figures being from drawings by the author, illustrate satisfactorily this monograph, which is of special interest, first as giving an account of a rare group of medusae, and secondly because of its sad associations. Dr. Conant was a talented and high-souled young zoologist, who seems to have sacrificed his life to a sense of duty and devotion to others.

During this last stay in Jamaica, Conant seems to have been working largely on physiological problems especially of the sense-organs, such as the action of retinal pigment-cells under the influence of light and darkness; and also on the embryology of the Cubomedusae. We are glad to learn from Prof. W. K. Brooks, that Conant's notes are so full and so advanced that he hopes to be able to have them completed and published before long.

W. A. H.

OUR BOOK SHELF.

Special Report on the Beet-Sugar Industry in the United States. Pp. 240. (Washington: Government Printing Office, 1898.)

FOR some time the United States Department of Agriculture has been instituting and directing experiments to ascertain where sugar-producing plants can be grown most profitably. The present volume contains the results of this investigation so far as concerns the beet-sugar industry. It is divided into two parts, one part consisting of the report of the chemist of the Department, Dr. H. W. Wiley, while the other consists of the report of the field agent, Mr. C. F. Saylor, who has personally visited and examined the plantations and factories concerned in the beet-sugar industry in a large number of districts.

The facts and figures presented in the volume justify the attention which the Department of Agriculture has given to the development of this important industry. How widespread is the interest taken in the subject may be judged by the fact that 150,000 copies of a farmers' bulletin upon sugar-beet were applied for last year, and 60,000 copies of the present report have been printed for distribution.

Numerous packets of sugar-beet seed were sent to different parts of the United States last year with the object of obtaining information as to the regions in which the sugar industry is most likely to succeed. There are, however, such great differences in soils and climatic conditions in the United States, that seeds which are suitable for one locality may not succeed in another. Dr. Wiley therefore points out that the experiments which the Department of Agriculture has conducted for several years in the analysis of beets, and the delimination of areas suited to beet culture, require now to be supplemented by a more rigid scientific attempt to develop beets of characteristics best suited to the various localities.

The opinion of Mr. Saylor upon the industry is decidedly optimistic. He says: "There is no doubt that the United States has a wide and varied extent of land that will successfully grow high-grade beets, that the enterprise of the people of this country will appreciate this fact, and that in a short time all the sugar consumed in this country will be furnished by our own people." Whether this prediction will be fulfilled during the next few years remains to be proved; but, in any case, the Department of Agriculture is doing its best to educate and assist the farmers who cultivate lands upon which the sugar-beet can be successfully grown.

Traité d'Algèbre Supérieure. Par Henri Weber. Traduit de l'allemand sur la deuxième édition par J. Griess. Pp. 764. (Paris: Gauthier-Villars, 1898.)

THIS is a translation of the first volume of the second edition of Prof. Weber's "Lehrbuch der Algebra," and will doubtless be welcome to those who are more familiar with French than with German. The translation appears to be trustworthy, although a few misprints have crept in here and there which are not in the original; thus on pp. 71, 72, the indices $a_1, a_2 \ldots a_m$ should be replaced by

$\mu_1, \mu_2 \ldots \mu_m$, and on p. 150 $f(x)$ has been printed instead of $f'(x)$. On p. 73 the phrase "en outre" is an imperfect equivalent for "wir setzen noch," and is likely to make the reader suppose that the symbol $\Phi(x, \xi)$ has been already defined. The handsome appearance of the volume, and the excellence of the printing, fully maintain M. Gauthier-Villars' high reputation.

The first edition of the "Lehrbuch" was reviewed in this journal at considerable length, so that it is unnecessary to give here any detailed account of the contents of this volume. Prof. Weber has introduced various improvements in detail, and added, amongst other things, an account of Lagrange's interpolation formula, and of Hurwitz's very interesting researches on Sturm's theorem. The extreme value and originality of the treatise become more evident the more carefully it is studied; the appearance of this translation, as well as that of the second edition at home, indicates that its great merits are being duly appreciated. G. B. M.

A Manual of the Grasses of New South Wales. By J. H. Maiden. (Sydney: Gullick, 1898.)

BROUGHT out under the authority of the Minister for Mines and Agriculture for New South Wales, the Government botanist publishes a very useful account of the grasses of the Colony. The number of species indigenous to the Colony is stated at 196, comprised in 56 genera. These numbers may be compared with the 95 species belonging to 48 genera reckoned by Hooker as natives of these islands. Under each species, in addition to the technical diagnosis, the vernacular names are given, with a reference to the published figures; the habitat and range of the species, and an account of its value for fodder and for other purposes. Then follows a key to the genera, and under each genus a key to the species. In the case of a number of the more useful or more common species, full-page illustrations are given. The volume is a very useful and valuable one; but, considering its purpose, it strikes us that its practical value would be increased by either a general description of the flower of grasses, or a glossary of technical terms; unless indeed, Australian farmers are much better acquainted than our own with botanical terminology.

Manuel de l'Explorateur. By E. Blim and Rollet de l'Isle. Pp. vii + 260. (Paris: Gauthier-Villars, 1899.)

THE object of this volume is to provide travellers in little-known regions with information which will enable them to record particulars of service to geography concerning the land traversed. In the first chapter the methods are described for determining and representing approximately the route followed and the details of the surface, using a prismatic compass and an aneroid. The astronomical observations required to define positions along the route are then explained, and it is shown how the combination of these observations with the rough survey enables an approximately accurate representation of the journey to be laid down. The determination of heights and distances by levelling and triangulation are described in the third chapter, for the instruction of explorers who wish to make a detailed study of particular districts. The two remaining chapters deal with systems of projection for the conversion of the observations to maps, and the choice and transport of the instruments referred to in the text. The sextant is not included among the instruments, the astronomical observations being made with the theodolite instead. No instructions are given as to what to observe in natural history, geology, anthropology, or other sciences; hence, the volume is not to be compared in value with the "Hints to Travellers" published by the Royal Geographical Society. Nevertheless, as a clear and very elementary manual on surveying and practical astronomy for travellers who explore without having received a preliminary scientific training, the book may prove of service.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Heredity and Fertility.

AS Prof. Karl Pearson in his paper "On the Law of Ancestral Heredity," published in the *Proceedings* of the Royal Society, alludes to an investigation which he has apparently commenced into the inheritance of fertility in man, it may be of interest now to publish one which I completed some years ago, but which for various reasons has not appeared in print.

The problem to be solved was:—Do marriages of heiresses prove more or less fertile than ordinary marriages? The first desideratum was of course to get a practically homogeneous class from which to obtain the necessary data. The families enrolled in "Burke's Peerage and Baronetage" sufficed. Taking the volume for 1892—just published when this investigation was commenced—there were in it of the present generation 265 ordinary or non-heiress marriages which had produced an average of 3·8 children per marriage, forty-eight of which, or 18·5 per cent., were absolutely sterile.

Now an heiress, so called in "Burke," may be considered of the same class as an only child. Hence, taking care that both parents lived long enough after the birth of their first child to have had others, I extracted all the marriages of heiresses and female only children that occurred in "Burke" for the present generation, with the addition of a considerable number from the past generation contained in "The Lineage." There resulted:—243 marriages, averaging 3·74 children per marriage and 11·9 per cent. marriages absolutely sterile. These figures show that there is practically no difference in the fertility of ordinary marriages—3·8 per marriage—and the 3·74 fertility of heiresses and only children: the small difference of six-hundredths per cent., on so small a number as 250 marriages, being well within the ordinary limits of error. It implies that with greater numbers the results would probably be similar. Not so, however, when we come to consider the number of marriages which are absolutely sterile, for these are so much fewer with the only children marriages—6·6 per cent.—that we must say when they are fertile they are more fertile than the others.

But the problem may be attacked from the other side. If female members of the smallest families possible tend to bear fewer children than the female members of families of ordinary size, the female members of large families would tend to bear large families. Is this so? With a much greater amount of labour than would be imagined, I extracted from the same work some marriages of ladies who were members of families of five or more, *i.e.* had in each case four or more brothers or sisters, with the result that 250 marriages averaged 4·25 per marriage with 13·6 marriages quite sterile.

Summarising, we get then ladies of small families average 4·06 children per marriage, 11·1 per cent. marriages being quite sterile.

Ladies of ordinary families average 3·8 per marriage, 18·5 quite sterile.

Ladies of large families average 4·25 per marriage, 13·6 quite sterile.

This shows that the more contrasted the ladies are as regards number of brothers and sisters, the more nearly allied are the numbers of their children and the relative amount of absolute sterility. A conclusion tending to show that the cause under investigation is not a *vera causa*.

Does the female influence show itself in a change in the proportion of male to female children, assuming of course a chance distribution of the husbands as being members of small, ordinary, and large families?

	Sons.	Daughters.	Total	S. to 100 D.	Sterile.
243 heiress and only-child marriages	492	414	906	107 sons	11
265 ordinary marriages ...	514	528	1042	97 sons	18·5
250 large family marriages	553	510	1063	108 sons	13·6

The same result as before—the most contrasted classes give the most similar results.

If heredity has anything to do with this matter, which so far seems improbable, it may arise from the other side—the father's. Hence I extracted marriages of only sons, of sons of ordinary

marriages, and of sons who had four or more brothers or sisters, and found that :—

	Children per marriage.	Sons to 100 Daughters.	Sterile.
191 only sons	4·09	116 sons	8·4 per cent.
265 sons of ordinary families	3·8	97 sons	18·5 ,,
500 sons of large families..	3·8	110 sons	12·4 ,,

These results point rather to the conclusion that could have been surmised: only sons being usually better off, have no reason to restrict the size of their families, as is so often necessary where a fortune has to be divided among many, and hence they have larger families.

Adding the three separate parental classes together, we have :—

	Sons.	Daughters.	Total.	Per marr.	Sons to 100 Daughters.
434 F. and M. only children	912	776	1688	3·89	117
265 F. and M. ordi- families	514	528	1042	3·9	97
750 F. and M. large families	1558	1424	2982	3·98	109
			5712		

Which shows that the number of children per marriage is so nearly similar that with a larger number of marriages to deal with they would probably be the same. Comparing the figures in the last column brings forth the most curious result of the investigation, that the marriages of members of ordinary sized families have a smaller proportion of sons to daughters than in the case of the other marriages.

The size of the families of the various classes dealt with may prove of interest, although nothing of great importance can apparently be drawn from the figures. The table contains the percentage of children per hundred marriages :—

Number of family.	Sterile. 0	1, 2	3, 4	5, 6	7, 8	9 & over.
Marriages of—						
Only female child ...	11	26	26	24	9	4
Only male	9	30	25	15	12	9
Ordinary	18	19	24	18	11	10
Daughter of large families	14	23	16	19	12	14
Son of large families ...	12	26	25	18	10	8
Total	64	123	117	95	54	42
Average	12·3	10·2	9·7	8	4·5	3·5

And, now, what are the final results to be drawn from the foregoing analysis? That, as a matter of fact, there is in no case a difference of sufficient magnitude to enable us to say that the fertility of either male or female in the human race is in any way correlated to the fertility of their fathers or mothers, and *a fortiori* correlated to the fertility of their grandparents.

Churchfield, Edgbaston. F. HOWARD COLLINS.

"A Short History of Scientific Education."

IN Sir Norman Lockyer's address, under the above title, reprinted in NATURE of October 13, he is reported to have said: "Before the Reformation the universities were priestly institutions, and derived their authority from the Popes. The universities were for the few; the education of the people, except in the various crafts, was unprovided for. The idea of a general education in secular subjects at the expense of the State or of communities is coeval with the Reformation. In Germany, even before the time of Luther, it was undreamt of, or rather, perhaps, one should say, the question was decided in the negative." . . . "With the Reformation this idea spread to France."

The whole passage seems to have been taken from that travesty of "The History of Pedagogy" compiled by Dr. Gabriel Compayré (compare pp. 114-115 and 120), and it is unfortunate that Sir Norman Lockyer should have followed so untrustworthy a guide.

For the statements contained in the above-quoted sentences are in direct opposition to the facts as ascertained by the best authorities in the matter. It is quite true that education owes much to the bishops and monks of the centuries before the Reformation, for it was in the episcopal seminaries, which formed a part of the bishop's own household, and in the great monastic schools, such as those of Cluny, Bec, St. Gall, and numerous others, that the torch of learning was kept alight in the troublous times when the laity were mostly fighting to resist the incursions of barbarians, or warring one with the other.

The priestly influence was therefore an influence for good. More than this, such Popes as Innocent III., Honorius III., Benedict XII., Gregory IX., Urban IV., to name no others, deserve the gratitude of mankind of all ages for their persevering efforts to improve the state of learning in the schools and universities of their times. Sir Norman Lockyer tells us that the "universities were for the few." How is this statement to be reconciled with the fact that students flocked to the universities in the days before the Reformation in multitudes so great, that we find it reported, that in the thirteenth century some ten thousand scholars attended the classes of the University of Bologna at one time, with another forty thousand at Paris, and thirty thousand at Oxford, while at Bordeaux a single college boasted of upwards of two thousand scholars. Even allowing that the numbers are exaggerated, it is indisputable that in this century the universities were crowded with students. Nor were these scholars all clerics, nor yet the sons of the nobles and well-to-do citizens, but mostly poor men—a scholar and a poor man being almost synonymous terms. Does not our own Chaucer describe the Clerk of Oxenford as "full hollow and threadbare?" And this, too, at a period when printed books were either altogether wanting or were a rarity. The number of universities founded in Europe in pre-Reformation days has been reckoned as sixty-six.

And what is true of universities is true also of elementary and grammar schools. In this connection, the first essay of John Charles Tarver's collection, "Debateable Claims," is worth referring to. "Fifty years ago," he writes, "the Reformation was popularly regarded as the very first beginning of enlightenment. Up to that time a crass and brutish ignorance was supposed to have prevailed . . . Since the middle of this century this view of our history has been considerably modified . . . How were the middle classes taught before the Reformation? The popular view is that they were not taught at all till Henry VIII. and his children, especially Edward VI., reserved something from the spoils of the Church endowments for grammar schools. A more enlightened view holds that incidentally the monasteries themselves were teaching establishments, and especially that the friars were not only preachers, but teachers . . . we should hardly have expected to find that the period of the Reformation was a period of indifference to schools; it was more than that, it was a period when schools were suppressed" And further on: "Again, the Reformation in its later stages was distinctly an upheaval of ignorance: the value of the old methods of teaching was not understood; 'the baser sort,' armed with the text of the Bible, thought all other learning superfluous; they regarded it, as classical learning is regarded by the scientific smatterer of to-day, as antiquated and superstitious. In Germany, according to Dr. Scherer, this attitude of mind contributed to the Counter-reformation; for contempt of learning having destroyed the teachers, when in the fulness of time the want of them was felt, the Jesuits were ready to take their place." In Mr. Leach's "English Schools at the Reformation," we learn that in England about the year 1546 there was one grammar school for every 8000 people, instead of one for every 23,000, as was the case in 1865; so that, at least in England, it is not correct to state "that the education of the people was unprovided for."

And what is true of England is true of other countries. As a set-off to the reference made by Sir Norman Lockyer to Luther's laudable endeavours in the cause of free education for the people, let us take the following quotation from a decree drawn up in the days of the Anglo-Saxons. "Mass-priests shall always have in their houses a school of learners; and if any good man will trust his little ones to them for lore, they shall right gladly receive and kindly teach them. . . . They shall not, however, for such lore, demand anything of the parents, besides that which the latter may give of their own will." This decree first appears in the Council of Vaison, and re-appears in the acts of several Councils of England, France, and Italy: for instance, in the Carlovingian Council of Orleans, and in the Constitutions of Vercelli. The request of the States General of Orleans in 1560 to Francis II., quoted by Sir Norman Lockyer, is therefore nothing new in the matter of free education. In addition to the Constitutions of Vercelli, those of Dado of Verden, and Heraclius of Liege, ordain the establishment of "little" or parochial schools, wherein poor children of both sexes, about the age of seven years, are to be taught gratis. That free

schools existed in England before the Reformation, as for instance those at Wisbech, Week St. Mary, Wimborne, Darlington, and Chipping Campden, appears from Mr. Leach's researches before referred to (pp. 110–114). In fact, the very idea of receiving payment for teaching was scouted until the introduction of secular teachers about the beginning of the eleventh century.

And yet Sir Norman Lockyer speaks of "the iron heel of priestcraft"—an ugly word—as arresting the "new spirit" presumably of free education of the people. Nor is his uncomplimentary reference to the Jesuits in France more according to facts. However what the Society of Jesus has effected for the cause of education, both literary and scientific, is too patent to any unbiassed student of the history of education to need discussion. Moreover, I should be needlessly occupying space in this journal. A. L. Cortie.

Stonyhurst College, October 23.

Organic Variations and their Interpretation.

I hope you will allow me to correct two serious errors in Prof. Weldon's reply to my criticisms.

I was never foolish enough to assert, as he implies that I did, that the theory of natural selection attempts to answer the question whether modifications originate accidentally or not. I said that this was the question between the adherents of the theory and its opponents. I quite agree with Prof. Weldon that the theory of natural selection does not involve a theory of the origin of variations. For that reason it is not by itself a theory of evolution.

Prof. Weldon asserts that I said there was no evidence of the entrance of fine mud into the gill-chambers of crabs during life. I said, or wrote, nothing of the kind. He found china clay in the gill-chambers of the individuals which died in his experiments, and I pointed out that this was no proof that the crabs had died because their branchial apparatus was unable to keep out the particles of clay. The clay was not found in the gills of the survivors, and he inferred that they owed their survival to more efficient filtration, due to their relatively narrower frontal breadths. I merely pointed out that the inference was not valid because the dead crabs had been in the muddy water after death, while the survivors were killed after removal.

I do not admit that Prof. Weldon has successfully vindicated his evidence or his conclusions against my criticisms; but as you, Sir, are unable to allow me any more space, I must thank you for printing my first letter, and leave further discussion of the matter for some other opportunity.

Penzance, October 22. J. T. Cunningham.

SCIENTIFIC EDUCATION IN RURAL DISTRICTS.

Among the problems of technical education which County Councils have had to face, the most difficult is the bringing home of the importance of scientific training to those engaged in agriculture and in rural industries generally. A study of the results achieved in the various counties very clearly brings out the fact that while considerable progress has been made in manufacturing centres where the practical bearing of science is more or less obvious, the agricultural counties have hitherto failed to show a similar progress as the outcome of their efforts to improve the rural industries. Many causes are contributing in this country to check advancement in rural technical education. The general depression of agriculture, the conservatism and apathy of farmers and landowners, the high cost of carriage of farm produce, and the incompetence of technical instruction committees are among these causes; but it would be out of place to discuss such matters in the columns of a scientific journal, and we are content in admitting that the technical committees in agricultural districts have had a far more difficult task imposed upon them than the committees of urban manufacturing centres have ever been called upon to perform.

In bringing under the notice of the readers of Nature an educational movement which we are firmly persuaded is a movement in the right direction, we have primarily in view the fact—obvious to men of science, but, unfortunately, not so obvious to those more immediately concerned—that agriculture in its widest sense is as much dependent upon scientific research for its advancement as any other industry. The great importance attached to agricultural stations in the United States and Canada, and on the continent, and the splendid results in the way of agronomic research which are being achieved at these stations, amply testify that other countries are alive to their agricultural welfare. All that has been done in this country by those great pioneers, Lawes and Gilbert, has been the result of private munificence.[1]

In view of the fact that the results of scientific research are bound with the progress of time to make themselves more and more felt in all kinds of rural industries, and bearing in mind also the slow rate of development in this direction in our country, we are convinced that the best chance of enabling our agricultural population to appreciate the importance of research and to meet competition is to give the rising generation an opportunity of acquiring some knowledge of sound scientific principles as a part of their early training. If the present generation of farmers and landowners cannot or will not bend to the inevitable, and endeavour to cope with difficulties by scientific method, then, at any rate, let facilities be given to their children for the acquisition of such scientific habits of mind as will enable them, without actually becoming experts in any particular science, to realise exactly how they are situated with respect to their competitors. It is hardly necessary to point out in these columns that in all rational schemes of technical education this principle is recognised as sound. It is remarkable, in view of this acknowledged principle, that so many technical instruction committees should have attempted to begin their work at the wrong end, and should have expended large sums in encouraging sporadic teaching by specialists to adults who, for lack of proper training, are totally unprepared for specialisation in any direction. In most cases a critical analysis of the results obtained under this system shows that unintelligent manual dexterity is the utmost that can be achieved. This, in our view, does not constitute technical education; certainly, so far as agricultural industry is concerned, this kind of instruction is not likely to be of any permanent value.

The agricultural industries may be regarded as furnishing a rallying point round which several distinct branches of science meet. To insure success in such occupations when all the resources of science are being utilised by our competitors, it is becoming more and more imperative that the education of the farmer should, at any rate, be placed on a scientific foundation. We cannot, unfortunately, look at present to the elementary schools for any help in this matter. The children leave too early in life, and such science teaching as they receive (if any) is quite inadequate. The sporadic system encouraged by some County Councils has already been condemned. Still more unfortunate appears to us to be the frittering down policy of administering the technical education grant in the form of doles to districts in proportion to the number of the inhabitants. The few want educating in the thinly populated agricultural districts quite as much, or even more, than the many in the towns. It is more costly to educate the few than the many; therefore the rural districts require more financial aid proportionally than the towns. Under the system referred to, the country districts get less. If an "intelligent foreigner," who came over to inquire into our educational systems since the passing of the Technical Instruction Act, were told that the degree and quality of the education given to a boy or girl had been made dependent on the number of inhabitants per square mile

[1] The fructicultural station established by the Duke of Bedford and Prof. Pickering at Ridgmount also comes under this heading.

in which the child happened to reside, he would be justified in passing on with a smile and a shrug.

Owing to the insufficiency of the educational machinery in country districts, and the disproportionate assistance given to urban centres under the decentralising policy, another evil has arisen which threatens to cripple still more seriously the already languishing rural industries. By the examinational selection of pupils for scholarships the best intellectual products of the country districts are gradually being weeded out, and all the skill and intelligence for which the land is thirsting is being diverted into other channels. This process, if allowed to go on, can only have one result: there will be left such an inferior residue that some future Minister of Education will have to deplore, even more emphatically than did Sir John Gorst in his memorable speech in the House of Commons last June, the barrenness of the outlook with respect to rural education. Still louder will go up the cry of the economist, that while the land is lying barren for want of skilled attention, and the villages are becoming depopulated, the towns are becoming overcrowded to the starvation point of competition.

In order to counteract these evils, it is desirable that the resources of science should be made as available to the inhabitants of the country as to the dwellers in towns. A long acquaintance with the habit of mind of the average British farmer has convinced us that the only chance of salvation in the future is to bring the educational machinery into his neighbourhood. It is useless to tell him that he must send his children to some distant school or college where science teaching forms part of the curriculum. He knows nothing and cares nothing about science. He looks upon learning as a dangerous thing, and associates chemistry with bogus fertilisers. An experiment which leads to no practical issue causes a chuckle, and if a downright failure is the result, he is rather pleased than otherwise. The so-called "agriculture" of the certificated schoolmaster, which was let loose in some counties in the early days of the technical education movement, is very largely responsible for hardening the scepticism of the practical farmer towards science.

Perhaps we are over-sanguine in the belief that the agricultural salvation of our country depends on the scientific education of the coming generation. At any rate the belief has taken practical form, and a school of science has been founded at Bigods, near Dunmow in Essex, by one of the writers (F. E. W.), which it is hoped will set an example throughout the country. No claim is made for any particular educational originality in this venture. The *raison d'être* of the school is that it serves a thinly populated agricultural district where there is no organised science school in existence. There are districts of a similar kind all over the country, and there is a distinct need for such schools in these districts. The Essex County Council has extended some aid towards the Bigods school, and it is to be hoped that other County Councils will follow suit in their own districts. Certainly no better use of the "whisky money" can be made in agricultural districts than in establishing schools of science where the children can receive a sound training, extending over the three or four years between their leaving the elementary school and their entry into life as bread-winners. In some cases it might be possible to develop existing schools in the desired direction; but, on the whole, a fresh start would seem to be the preferable course. The average country grammar school is generally too much hampered by ancient tradition to meet modern requirements; the education in such foundations has not a sufficiently scientific bias, and the particular class of students whom it is our desire to see catered for, do not take kindly to the grammar school curriculum, apart from the question of cost, which is more than the small farmer or proprietor can afford.

With respect to the curriculum at Bigods, we have at present adopted that laid down for schools of science by the Science and Art Department. In most respects this scheme seems adaptable to our requirements, which may be described briefly as an education which, while allowing a certain amount of time for literary subjects, gives also a general scientific training with some manual training. No specialisation will be allowed till the pupils have passed through the elementary stage, and in the advanced course the sciences bearing on agriculture will be given extra prominence. A large mansion has been placed at the disposal of the school as a residence for the principal and for boarders who reside too far off to come to the classes daily. There is plenty of land about the establishment for experiment plots, apiaries and poultry runs, and a farm adjoining the estate is available for field demonstrations. For the advanced classes the services of the County Council Staff Instructors, who are experts in their various departments, will be requisitioned. The school has made a start with some forty pupils, of whom about twenty-three are considered qualified to go through the school of science; while the remainder are in course of training for this curriculum. One especial feature of the scheme is the mixed education of boys and girls together in the same class. This system has been found to work admirably in other schools, both in this country and elsewhere, and it is intended to give it a fair trial in Essex. So far as experimental science is concerned, girls certainly are quite as keen and do just as well as boys if they are properly taught. The only point of difference in the education of the sexes is that the girls sacrifice some portion of the manual training and science in favour of domestic subjects, such as cookery, needlework, and domestic economy. Chemical and physical laboratories, a workshop and well-equipped laundry are, of course, essential parts of the institution.

The educational experiment which has been inaugurated in Essex is one which we venture to think is worthy of success and encouragement. The main difficulty with which we shall have to contend will no doubt be that of persuading the parents to allow their children to remain long enough at the school to complete their education. At any rate, the chance has now been placed in the way of the inhabitants of a district which has hitherto been devoid of institutions for carrying on any systematic scheme of secondary education. The firm belief that such establishments will do more permanent good to the agricultural welfare of this country than any amount of sporadic teaching or evening courses to people already mentally and bodily weary with a long day's work, has prompted the expenditure of money, time and thought, which have been necessary to found this school. Of equal weight has been the conviction that the mental discipline imparted by sound instruction in the principles of such sciences as are taught under the curriculum, is the best of all equipments that can be given to the agriculturist on his entry into active life. In order that would-be benefactors of rural education need not be alarmed, it may be pointed out that large institutions are not essential. At Bigods the laboratories of the school of science are available for about twenty-five pupils. We shall be satisfied if for some years this department of the school can be maintained at this number in the elementary and advanced stages. The great desideratum of the time is the establishment of numerous small but thoroughly efficient secondary and technical schools in appropriate centres, so that all the rural districts may be catered for. The general level of intelligence in the neglected country districts is bound to be raised in the long run by such means—not only by the direct effect of the training, but indirectly by reacting upon the elementary schools and compelling them to increase the efficiency of their teaching.

FRANCES EVELYN WARWICK.
RAPHAEL MELDOLA.

IN THE FORBIDDEN LAND.[1]

AMONGST the many travellers who wander to and fro in the untrodden parts of the world there has lately been a marked development of the journalistic class.

Ever since the days when the *New York Herald* achieved such a grand success with Mr. Stanley, and was instrumental in the discovery not only of the lost Livingstone, but of a vast new world for future enterprise, we have had from time to time new schemes for exploration initiated and supported by leading exponents of popular literature. The difference between the special correspondent and these emissaries of what we may call geographical journalistic enterprise lies chiefly in this; the special correspondent finds the subject-matter of his correspondence ready made for him; he has but to record the sequence of events as they pass before his eyes; over them he has no control, and his success depends largely on the chances and accidents of a campaign or political mission. The journalistic geographer, on the other hand, has to make his own straw before he can produce his bricks; and if startling sensation and thrilling incident are necessary to his success, he must find them for himself. There can be no reasonable objection to this form of enterprise, although the dangers that beset it (both moral and physical) are obvious. Haply the traveller who starts in search of a sensation may discover much that is of real value to science, and may prove to be a sound geographer. But his *métier* should not be confounded with that of the true geographer, the seeker after scientific truths, whose aim is the enrichment of the world's store of exact knowledge, and who will, in the pursuit of his object, avoid rather than court those situations which may peril the safety of his mission and impede his purpose, even if they may add picturesque detail to his narrative.

Mr. H. S. Landor is an adventurous traveller who possesses by heredity the eye of a poet, and a great power of graphic description. His book is interesting all through, but we must not take him too seriously as a great geographer. A journey through the Kumaon district (which constitutes a great part of his book) is but the periodic experience of every official Englishman who is appointed to the administration of that corner of the North-west Provinces, and even a visit to the Mansarawar Lake has not proved to be beyond the powers of several sportsmen lately, who have been more fortunate than Mr. Landor in their relations with the frontier Tibetan authorities. But beyond the Mansarawar Lakes, on the direct route to Lhassa, it has been known for many years that no European has a chance of penetrating far. It is a most jealously guarded route, and those travellers who have studied the subject of traversing Tibet beforehand, and who have lately succeeded in crossing the great northern plateau from west to east, have entered Tibetan territory at points less exposed to the hostile and unrelaxed vigilance of the Tibetan officials. It is true that the region of the Mansarawar Lakes, and, indeed, the whole route to Lhassa has been pretty thoroughly explored and surveyed under conditions of much less difficulty than those experienced by Mr. Landor; but this has been accomplished by trained employés of the Indian Survey department, who, being either residents of Kumaon or educated Tibetans, have been able to identify themselves with the people of the country, and have experienced no particular difficulty in reaching Lhassa, and describing it in comprehensive

FIG. 1.—Escaping in a snowstorm.

[1] By A. Henry Savage Landor. Two vols. Pp. xx + 320, and xvi + 263. (London: W. Heinemann, 1898.)

official reports. Mr. Landor's map differs in no essential particular from that of the Indian Survey, except that he shows an error in longitude. His separation of the Rakas Tal from the Mansarawar Lake by a dividing ridge of some elevation cannot be accepted as a final determination of the real nature of that division, the continuity of which probably depends on the amount of water in the two lakes. Evidence of their connection exists, and in face of the fact that Mr. Landor only partially traversed the dividing ridge, this evidence cannot fairly be set aside.

It speaks much for Mr. Landor's pluck and endurance that he should have succeeded, with two followers only, in penetrating some 200 miles along the high road to Lhassa. Here a forcible conclusion was put to his journey, and his opportunities as a geographical observer came to an end. But what was wanting in opportunity for scientific research was more than balanced by the excitement (unexpected and most unpleasant) of thrilling personal adventure in the hands of the Tibetans; and it is this which gives such strong interest to Mr. Landor's narrative. He crossed the frontier by the Lampiya pass after a preliminary ascent of the Mangshan mountain. After reaching the top of the mountain (22,000 feet) at night, and recording his observations by the light of the moon, he witnessed some extraordinary optical phenomena; and then collapsed under the pressure of sensations such as few travellers have experienced, and from which we may venture to say that none before have ever recovered. High altitudes, no doubt, produce curious effects on the powers of vision. On another similar occasion Mr. Landor observed all the planets and stars oscillating in the sky with something of the motion of a swinging pendulum.

From the Mansarawar Lake eastwards his journey was one of constant difficulty and danger. He evaded the Tibetan outpost by escaping from his camp into the mountains during a severe snowstorm, and wandered amongst the hills for some days before he regained the direct road to Lhassa. So constant were his encounters with bands of dacoits on this much-traversed route, as to lead to a suspicion that these dacoits must gain a precarious livelihood by robbing each other. Their cowardice was, however, phenomenal (and in this trait of Tibetan character all travellers agree), and the simplest demonstration of resistance was enough to put them to flight. Gradually reduced to two followers, with two yaks to carry his small equipment, Mr. Landor still pressed on eastwards until he lost half his baggage in crossing a river. He was driven to a Tibetan encampment for food and for the purchase of ponies, and it was whilst negotiating the latter that he and his two companions were treacherously overpowered and cruelly bound, under the direction of a Tibetan official, who had probably been despatched from Lhassa to prevent his further progress. If Mr. Landor was in search of a sensation, he certainly found it now.

FIG. 2.—Crossing the "divide" between the sources of the Indus and the Brahmaputra.

The rest of his book is a lively description of his sufferings and those of his faithful retainers during their forcible removal from Tibetan territory. One hardly knows which to admire most—the supreme contempt for his captors that Mr. Landor never failed to evince even under the most harrowing circumstances; the pluck and nerve which he showed when face to face with death; or his extraordinary athletic powers, as proved by his clinging to the saddle with his knees when his hands were tied behind him, and a heavy-weight Tibetan was pulling him backwards with a rope tied round his neck; or when, triced up by hands and feet (as illustrated by himself), he was able to liberate one hand and loose the ropes which bound his servant's feet, whilst he still remained suspended by the other.

With Mr. Landor's illustrations, two of which accompany this notice, we have no fault to find. The photographs are excellent, and his own drawings are powerfully descriptive of the impressions which remained in his mind after his adventures were over. The Kumaon hill track where he climbs round the face of the cliff is indeed a perilous path; but anything is possible in a region where the habitations of the natives can cling to the face of a wall in apparent defiance of all laws of gravity, as they do in the illustration which faces p. 159 of vol. ii. But with Mr. Landor's system of spelling we cannot agree. It is *not* the "geographical" system, and it is at first a little difficult to recognise well-known Hindustani words in the guise in which Mr. Landor clothes them. The words "Acha giao" (achcha jao) would not in the mouth of a Pahari gypsy mean "Go well" so much as "All right, clear out."

And there is one other subject which we think requires further investigation. The habits and manners of Tibetans have often been described, sometimes by themselves, sometimes by scientific observers. But Tibetans have never so far been classed amongst cannibals. The revolting details which Mr. Landor gives of the practices of the Lamas in connection with the last rites of a dead Tibetan are too horrible to be admitted without question. It should be remembered that Mr. Landor deals with a section of the Tibetan community which is directly connected with the great religious centres at Lhassa. It happens that it is about these centres that we possess the fullest information. No Lama in the neighbourhood of Darjiling would admit for an instant that such practices were common; nor will the reports of educated native travellers to Lhassa support the accusation. Mr. Landor carries his search for sensation just a little too far when he accepts in all good faith accusations such as this without an appeal to the best authorities.

With reference to the appendix to Mr. Landor's book, and the report of Mr. Larkin, the Deputy Commissioner of Almorah, the following extract from the *Pioneer Mail* of October 14 will be interesting.

"We have the best authority for stating, as we did the other day, that Mr. Landor was told that this report was confidential, that no copy was given him, and that he was not authorised to publish any Government report." The certified copies of depositions made in Mr. Larkin's Court should not be mistaken for Mr. Larkin's report.

T. H. H.

BODE'S LAW AND WITT'S PLANET DQ.

IN comparing the distances of the planets from the sun, it was early thought that there might be some law which would connect these distances together and allow us to calculate them correctly or even approximately. Kepler, as long ago as the beginning of the seventeenth century, thought that he had discovered such a law; but as he could not account for the anomalous space between the orbits of Jupiter and Mars, he abandoned the idea "of reconciling the *actual* state of the planetary system with any theory he could form respecting it, and hazarded the assertion that a planet really existed between the orbits of Mars and Jupiter, and that its smallness alone prevented it from being visible to astronomers." In the year 1772 Prof. Bode announced a law which gave a curious approximate relation between these distances, although it seems certain that Titius of Wittenberg discovered and formulated it some years previously, pointing out "the existence of a remarkable symmetry in the disposition of the bodies constituting the solar system." This law was very simple, and amounted to this: If to each of the planets, beginning with the one nearest the sun, the number 4 be given, and to the second, third, fourth, &c., the numbers 3, 6, 12, &c., respectively, be added, then the resulting numbers, divided by ten, approximately give the values for the mean distances of each planet from the sun in terms of the radius of the earth's orbit.

The first six numbers calculated by this law gave with fair accuracy the relative distances of the planets; but there was one exception, namely the number 2·8, which represented the distance of a planet when there was nobody known: this exception was the same that puzzled Kepler in the formation of his law. Prof. Bode supposed, however, a hypothetical planet to fill up this gap, which probably was absent simply because it had not then been discovered. We may mention that at that time Uranus and Neptune had not been found, so that the discrepancy with regard to the latter planet, in which this law utterly breaks down, could not then have been noticed. As this one feature in the law could not otherwise be explained, namely the number which accounted for the distance of a planet between Mars and Jupiter, a planet which had never been observed, it was decided to make a thorough search and try to pick up this missing member. The discovery of Uranus in 1781, and its distance agreeing with the value as given by Bode's law, set many astronomers thinking, with the result that it was decided to make a systematic search in the heavens for this unknown planet. Although all those who undertook this search worked diligently to pick up this supposed body, it was left for Piazzi, the Sicilian astronomer at the observatory of the University of Palermo, to make the discovery of the first (Ceres) of those now numerous small bodies known as planetoids, asteroids, or minor planets, which make their journey round the sun between Mars and Jupiter.

Piazzi, it may be remarked, was at the time constructing a star catalogue, and discovered this small body in his usual course of work, thinking at first it was a new kind of comet.

This was the first of a series of discoveries which now followed one another, and, up to the beginning of this year, no less than 425 of these planetoids have been discovered. The question then was asked, Did Bode's law still hold good? Were these small bodies, which vary in size from 100 to 10 miles in diameter, remnants of one large planet which originally revolved between Jupiter and Mars at a distance approximately the same as that represented by Bode's number 2·8?

Taking the distance of the mean minor planet, namely 2·650, and comparing it with the computed value from Bode's law, namely 2·8, the agreement was found to be sufficiently satisfactory for such an approximate law. In the case of Saturn, the difference between the mean distance and that given by Bode's law is nearly three times that for the minor planet above mentioned, so that the law may be said to approximately hold good.

In the case of Neptune, which was discovered in 1846, the value of the mean distance, according to Bode's law, is far from the true one, so that the law in this case may be said to completely break down.

Quite recently another planet, not a member of the minor planet family, as far as we know, but one revolving by itself, in an orbit between Mars and the Earth, has been added to the members of the solar system. Does Bode's law account for this? Before answering this question, let us, first of all, confine our attention for a moment to the manner in which this body was discovered, and what we as yet know about it.

In the early days of minor planet discovery, the task of finding one of these heavenly wanderers was by no means a light one; for the watcher had not only to be provided with an excellent star map of the region of the sky he was studying at the time (he nearly always constructed one himself), but to make measurements of each of the bright points in his field of view, night after night, to see if he could detect any relative motion between them. Considering the number of stars in the

region under investigation, and the improbability of there being a minor planet in that region at that time, it can be quite well understood that such discoveries were the result of an immense amount of labour. By the use of the photographic method, all these difficulties are at once swept on one side; for, since the presence of one of these bodies can only be detected by its own motion relative to the stars around it, the photographic plate can at once indicate this. Further, by using a fairly wide angle lens, a far greater portion of the sky can be examined at one time than was previously the case, and therefore the chance of finding these bodies is considerably increased.

We have only to expose a photographic plate in an equatorially mounted telescope driven by clockwork at sidereal rate, then all stars will appear as circular discs, and any minor planet, which, of course, has its own proper motion, will be represented by a small trail, the length of this depending on the duration of the exposure and the amount of movement of the minor planet during that interval.

plate searched for are by no means easily seen. The plates, further, must always be carefully washed for some hours, in order to get rid of all trace of the hyposulphate of soda. It is an exceedingly easy matter to quickly dry photographic plates; but most methods, even that of the use of alcohol, are inclined to create disturbances in the film, such as unequal contraction, which render it unfit for accurate measurements afterwards.

Herr Witt therefore waited until the following day before the negative was examined. Not only did he find on it the record of the long-lost minor planet he was seeking after, but another one, Althaea (119), which had been previously discovered. With the help of a lens a further trail was noticed, but on account of its unusual length, which was an indication of a quick moving body, he thought at first it must be a comet. To verify this conclusion, the following evening he turned the 12-inch refractor towards the same region, and found in that position a stellar- not cometary-like body of magnitude 10 to 11. Without any further delay the dis-

FIG. 1.—Showing path of new planet in sky between August 14 and December 31, 1898.

At the present day numbers of workers are exposing plates on clear nights to detect both new and old members of this family, and it was during such a search that Herr Witt, of the Urania Observatory in Berlin, made the important discovery of this new planet.

Since the year 1889 a certain minor planet named Eunike (185) has never been observed, and it was with the intention of photographing this object that Herr Witt turned his telescope, on the night of August 13, towards the region of β Aquarii, previous calculation having told him that the planet should be in or near that region. After a two hours' exposure the plate was developed and washed, and left to dry until the next day, when it was carefully examined. It may be asked, why the plate, after development, was not immediately examined? Any one who is familiar with such work will know that not only is the film very soft, and therefore easily liable to be damaged, but that the trails on the

covery was at once communicated to the "Centralstelle" for astronomical telegrams, and by this means the news was immediately sent to a great number of observatories.

Curiously enough, on the same evening (August 13) that Herr Witt was fortunate enough to photograph the trail of this planet, Herr Charlois, at the Nice Observatory, was photographing the same region (probably with the same intention as Herr Witt). He also secured a record of the presence of this new body. Prof. Perrottin, the director of the observatory, did not, however, make the discovery known until after Herr Witt's announcement; nevertheless, although the latter is entitled to declare himself the real discoverer, both names should be handed down to posterity, as is the case with the discovery of Neptune by Leverrier and Adams.

It was not long, however, before numerous accurate observations of this new body were made, and they extended over a period of days (seventeen in number)

sufficient to allow that well-known indefatigable minor planet-orbit calculator, Herr H. Berberich, to compute its orbit. The accompanying chart (Fig. 1) shows the path of the planet in the sky from August 14 to December 31. The Roman figures in the chart from VIII to I correspond to the dates August 14, September 1, October 1, November 1, 15, December 1, 15, 31, of the present year.

Now comes the astonishing result of Herr Berberich's computation. The planet was not one of those small bodies which revolve round the sun between Mars and Jupiter, but was an entirely new body, its path lying for the main part within that of Mars.

Here are the elements of the planet's orbit as given by the calculations. It must be mentioned, however, that these elements cannot be considered as final, since more observations, extending over a much longer period, are required to ultimately establish the true elements. These elements, however, will not deviate very much from those given below.

Epoch 1898, *August* 31·5, *Berlin Mean Time.*

	°	′	″	
Mean anomaly	220	14	3·7	
Perihelion distance from ascending node ...	178	28	26·2	1898·0
Longitude of ascending node	303	48	53·0	1898·0
Inclination of orbit to that of the earth ...	11	6	57·1	1898·0
Eccentricity	13	13	3·8	

Mean daily movement, 2010″·131
Period of revolution round the sun, 645 days.

Taking the mean distance of the earth from the sun as unity, the new planet at perihelion approaches the sun to within 1·12 of these units, and when furthest away is distant 1·79 of these units. These values in the case of Mars are 1·38 and 1·67 respectively. We thus see that we can now no longer look upon Mars as our nearest neighbour (excepting, of course, our moon), for the mean distance of Mars from the sun amounts to 1·52, while that of the new planet is 1·46.

The accompanying diagram (Fig. 2) shows the relation of the new planet's orbit relative to that of Mars.

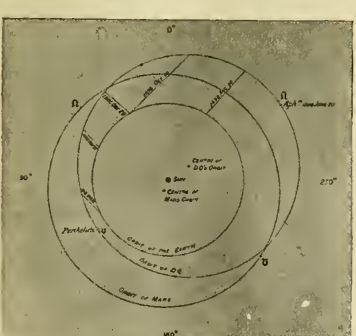

FIG. 2.—Comparison of orbits of Mars and the new planet D Q.

Assuming that Berberich's elements are correct, it is interesting to inquire into some of the relations which this orbit presents. Mr. Crommelin, to whom we are indebted for the above diagram, has considered such relations in his article in *The Observatory* (October, p. 372). A synodic period being two successive conjunctions with the sun as seen from the earth, this in the case of the new planet is 2·30692 years. We thus see that three synodic periods equal nearly seven years, so that after this period oppositions are repeated in nearly the same regions of the orbit. A closer approximation would be obtained if thirteen synodic periods, which extend over 29·99 years, were considered. As regards the time when the planet comes into opposition—a point of great importance, especially in the case of this planet—Mr. Crommelin tells us that, unfortunately, "an opposition under the most favourable circumstances took place in January 1894," and that we shall have to wait now until January 1924 until another equally favourable one occurs. In the years 1900 and 1917, only moderately favourable oppositions will occur, the planet in November of the former year then being of magnitude 8 or 9.

The close approach of this planet to the earth at times of favourable opposition will give us excellent opportunities of determining, more accurately than was possible before, the parallax of the sun—or, in other words, the distance of the sun from the earth.

The importance of a correct value of this quantity is very great, when it is considered that all measurements of distance in our solar system are based on it. Just as the foot is taken as a unit in measuring the side of a room, or a mile in measuring a strip of country, so astronomers adopt the mean distance of the earth from the sun as the unit in measuring the distance of Jupiter or Mars. A more accurate value of the standard of measurement for the solar system is, therefore, of the highest importance.

Since the new planet when nearest to and furthest from us will vary from the sixth to the twelfth magnitude, several useful photometric problems may be attacked. Thus, as Prof. Pickering suggests, the approximate diameter may be determined by comparing it with those of the brighter minor planets and satellites, on the assumption that the reflecting power is the same.

Again, the well-known law that light varies inversely as the square of the distance might be tested, as the planet's distance from the earth varies very considerably. At the same time, it could be determined whether there exists in the solar system any medium capable of absorbing light.

Let us now consider whether the law of Bode holds good for the presence of this new planet.

We give below a table showing a comparison between the true mean distances and those calculated by Bode's law.

Planet.	Distance.	Bode.	Diff.	Syn. period. Days.
Mercury ...	0·387 ...	0·4 ...	−0·013 ...	116
Venus ...	0·723 ...	0·7 ...	+0·023 ...	584
Earth ...	1·000 ...	1·0 ...	0·000 ...	—
Witt DQ ...	1·461 ...	? ...	— ...	644·7
Mars ...	1·523 ...	1·6 ...	−0·077 ...	780
Mean asteroid ...	2·650 ...	2·8 ...	−0·150 ...	Various
Jupiter ..	5·202 ...	5·2 ...	+0·002 ...	399
Saturn ...	9·539 ...	10·0 ...	−0·461 ...	378
Uranus ...	19·183 ...	19·6 ...	−0·417 ...	370
Neptune ...	30·054 ...	38·8 ...	−8·746 ! ...	367·5

In the above table the column headed "Bode" gives the distance according to the law of Bode, while the following column, that headed "Diff.," represents the difference between the true mean distance, as given in the second column, and that calculated after Bode's law.

A glance at this will show that the distance of the new planet does not fall into line at all, but, like Neptune, is an exception to the law.

Indeed, for the new planet, Bode's law does not even suggest a number, as there is no break between the distance accorded to our Earth and that of Mars. If we assume the law of Bode as mainly correct, then we must look upon the new planet as one of the minor planets gone somewhat astray.

There is, however, one outlet which believers in this law can take advantage of, namely, that perhaps the new body was originally part of the planet which, when broken up, gave rise to the group of minor planets. As opinion is still divided as to the true origin of asteroids, namely, whether they are the result of a large series of explosions of an original planet which revolved between Mars and Jupiter; whether they are the condensation of matter which originally was distributed in rings like Saturn, but which was disturbed by the action of Jupiter; or, lastly, whether they are the result of tidal action on the tenuous primitive masses, the presence of the new planet in this exceptional orbit might be accounted for on any of these hypotheses. Perhaps, for all we know, this planet may be one of several similar bodies which were so thrown off or perturbated from the original mass, that they were able to get into more favourable positions for being disturbed by the attraction of Mars when nearest them, and that their orbits were changed.

Mr. Rees, in a lecture before the New York Academy in 1897, suggested that "the very rapid augmentation in the number of minor planets indicates that there may be thousands or even millions in the zone: with more powerful telescopes and more sensitive plates we may hope to find many of these thousands. And perhaps the same agencies will discover asteroids between the orbits of all the planets." There is, however, no doubt that the orbits of some of the minor planets are not very dissimilar from those of Mars and Jupiter, and must be subjected at times to large disturbing forces by both these planets. That one, or even several, of these bodies may have been violently disturbed by Mars when in a very favourable position, and thus made to revolve in orbits more eccentric and inside that of Mars, does not seem at all improbable.

Jupiter also would be responsible for a great disturbing force, and it is as likely as not that beyond his orbit many of these small bodies pursue their paths; these, however, would probably be invisible to us on account of the greater distance. In fact, it seems more natural and in harmony with the solar system in general to consider this newly-discovered small planet as an unusually situated member of the minor planet group, than as a single condensed body which has from the beginning of its career been up till now an unseen major planet.

If future research on the movement of this new body should indicate the probability that we are dealing with a member of the minor planet group that has suffered considerable perturbations, then the law of Bode will, with the ususal exception (Neptune), still afford us the simple approximate means of quickly calculating the distances of the members of the solar system.

WILLIAM J. S. LOCKYER.

NOTES.

WE regret to see the announcement of the death of Mr. Latimer Clark, F.R.S., the well-known electrician, at the age of seventy-six.

PROF. JAMES A. CRAIG, of the University of Michigan, spent his summer vacation in London at work in the British Museum, on the astrological-astronomical tablets of the Kujundjik (Nineveh) collection known as the Illumination of Bêl. This is the most important series of unedited texts in the British Museum, and by far the most important in many respects to be found in any of the collections extant. Prof. Craig has worked upon it during the last three summer vacations, and has now completed all the texts of the series, which number about 130 tablets. His manuscript is already in the press with Die Hinrichssche Buchandlung, Leipzig, and will appear shortly in the "Assyriologische Bibliothek," in which the author has already published two volumes.

THE Paris correspondent of the *Chemist and Druggist* states that Dr. Calmette, Directeur of the Pasteur Institute at Lille, has endowed that body with a sum of 250,000 francs (10,000*l*.), representing the profits realised by the distilleries at Seclin by one of his inventions.

Natural Science, the impending decease of which was announced in the October number, has received a new lease of life. An editor has been found willing to take upon himself the burden of responsibility, so the journal will appear as heretofore during 1899, and, it is hoped, for many years to come.

THE Committee on endowment of the Franklin Institute, Philadelphia, is making an appeal for subscriptions to the endowment fund. It is of the utmost importance for the future prosperity and progress of the Institute, that a substantial addition to its annual revenues be acquired, not only to provide income sufficient to carry on its present work, but also to enable it to extend this in other directions.

PROF. ISRAEL C. RUSSELL, of the department of geology of the University of Michigan, has recently conducted a geological survey for the United States Government over the northern portion of the Cascade Mountains. The greater part of the work was in Washington State, and extended from the Northern Pacific railroad to the Canadian boundary, crossing the mountains several times. Among the places of interest visited was Glacial Peak, the height of which was verified.

AT the close of the last, and the beginning of the present week, the weather over these islands was of a very unsettled character. On Saturday, October 29, a cyclonic disturbance appeared off the south of Ireland, and subsequently passed to the Shetlands, causing gales, especially over the western and northern parts of the country, and rough weather in the Channel and Bay of Biscay, with very heavy rainfall generally, amounting in forty-eight hours to 1·26 inches at Greenwich and 2·48 inches at Pembroke, while thunder and lightning were observed at several places. At Camberwell Green (south-east London) a terrific squall, resembling a small tornado in its character, occurred at about 9h. 30m. on Saturday evening, overturning vehicles, uprooting trees, and causing much damage to buildings. The violence of the storm, the track of which was apparently from about E.S.E. to W.N.W., fortunately lasted only a few minutes, and was confined to a very small area, other places in the immediate locality experiencing nothing beyond strong wind accompanied by very heavy rainfall.

THE ordinary general meeting of the members of the Institution of Mechanical Engineers was held on October 26 and 27, Mr. Samuel W. Johnson, the president, being in the chair. The president announced that Sir W. H. White, Chief Constructor of the Royal Navy, had been nominated as his successor, Mr. T. Hurry Riches as a vice-president, and Sir William Arrol, M.P., Sir Benjamin Baker, Mr. Henry Chapman, Mr. W. J. Pirrie, and Sir T. Richardson, M.P., as members of the Council. In a paper on "Electric installations for lighting and power on the Midland Railway, with notes on power absorbed by shafting and belting," Mr. W. E. Langdon showed that an extensive loss of power takes place in shafting and belting, but this may be reduced by driving each tool or machine direct from an electric motor. With large tools or machines absorbing over one horse-power, there seems to be no question of the advantage derived from driving them direct by electricity. Mr. W. M. Smith described some recent practical experience with express locomotive engines. The train resistance was found to be considerably increased by side winds. On one trip it was found that the side wind increased the mean train resistance by about 3·558 lbs. per ton of load. The

dynamometer apparatus used in the experiments measured and recorded (1) the pull or push exerted by the engine on the train; (2) the distance run; (3) the speed; (4) the places of starts, stops, and stations; and (5) the time when starts and stops were made, and when stations were passed. The horse-power shown by the indicator diagrams differed from that recorded by the dynamometer, which was in a separate car. Usually, however, the ratio between the two horse-powers did not vary much. On an average the dynamometer horse-power was equal to approximately 64 per cent. of the indicated horse-power. Thus about 36 per cent. of the driving power was absorbed by the engine and tender.

Mr. N. R. Harrington and Dr. Reid Hunt have arrived in New York from the Nile valley, where they have been several months collecting *Polypterus* and other interesting and valuable cytological material. We learn from *Science* that the chief object of the expedition was to procure the life-history of *Polypterus* and its bearings upon the problem of the relation of the Crossopterygian fishes to the Amphibia. In the last few years the former theory that Amphibia sprang from Dipnoan fishes has gradually given way to the present view that *Dipnoi* are to be regarded as parallel to Amphibia from a common Crossopterygian origin. Several very successful expeditions have been sent out to procure material for the embryology of Dipnoans, notably that of Prof. Richard Semon from Jena, and that of Mr. Graham Kerr from the University of Cambridge. The former secured the complete life-history of *Ceratodus*, and the latter brought back the embryology and complete life-history of *Lepidosiren*, a South American form. But before the recent expedition nothing had been done upon the development of *Polypterus*, because of the exceptional difficulties which stood in the way of procuring material. Messrs. Harrington and Reid found that the fish did not occur in Lake Menzaleh during the low Nile period, but they came across several *Polypterus* near Ras-el-Ghelig. The best *Polypterus* fishing ground, not closed on account of the Sudan campaign, was at Mansourah, forty miles from the sea; and the party settled there for the summer.

The attention of botanists has of late years been turned to the biology of ferns, but there still remain a great many facts to be explained, and questions to be solved. Dr. Aurelio de Gasparis, in a paper to be published in the *Atti* of the Naples Academy, has brought to light a large number of new facts relating to ferns. Some of these relate to certain forms of dissemination not previously observed, others to the trophilegic action of the fronds, in connection with which certain arrangements have been observed, destined to facilitate the passage of water to the roots. The author has also discovered two new cases of myrmecophily, as well as a number of cases of acarophily among ferns, many of them very evident and easy of observation.

An interesting addition to the list of myrmecophilous plants furnished with so-called "extra-nuptial" nectaries is given by Prof. Federico Delpino in the *Rendiconto* of the Naples Academy, iv. 7. In the Botanical Gardens at Naples about seven or eight plants have recently been observed to possess these glands, which differ from the ordinary melliferous glands in not being associated with the floral organs and being provided for the purpose of attracting ants instead of for promoting fertilisation. The newly-observed cases occur in *Cardamine cheledonia*, L., *Lilium croceum*, L., *Dyckia regalis* and *D. remotiflora*, a species of *Aechmea*, *Iris foetidissima*, L., and *Vicia serratifolia*, Koch. The families of *Cruciferae* and *Bromeliaceae* are thus added to the fifty-eight families previously known to contain species furnished with the glands in question.

In a paper, published in the *Sitzungsberichte* of the Berlin Academy of Sciences, Dr. F. Johow states his belief that the number of flowers pollinated by the agency of birds is much smaller than is often stated. Humming-birds, in particular, since they feed entirely on insects, and not on nectar, play but a small part in the carriage of pollen. He describes, however, an unquestionably ornithophilous flower in a Chilian Bromeliad, *Paya chilensis*. The "nectar" in this flower is exceedingly abundant, but is not attractive to insects, being very watery, and containing but little sugar. It is, however, eagerly drunk by humming-birds, but more especially by the "Chilian starling," *Curaeus aterrimuus*; and these birds get their heads plentifully besprinkled with the pollen, which they then carry to other flowers.

Prof. Ramsay has an article on the kinetic theory of gases and some of its consequences in the November *Contemporary*. He explains Dr. Johnstone Stoney's application of the kinetic theory to the atmospheres of planets and satellites, and then considers the recent discoveries of gaseous constituents of our own atmosphere, with special reference to the new element "neon." The facts dealt with are summed up as follows: "We have seen, then, that the discovery by Lord Rayleigh of a discrepancy in the density of atmospheric nitrogen has resulted in the discovery of a new constituent of air, argon; its discovery has led to that of a constituent of the solar atmosphere, helium; speculations on the ultimate nature and motion of the particles of which it is believed that gases consist has provoked the consideration of the conditions necessary in order that planets and satellites may retain an atmosphere, and of the nature of that atmosphere; the necessary existence of an undiscovered element was foreseen, owing to the usual regularity in the distribution of the atomic weights of elements not being attained in the case of helium and argon; and the source of neon was therefore indicated. This source, atmospheric air, was investigated, and the missing element was discovered."

The expressions for the work done in magnetising a body have been given by Mascart and Joubert and Prof. J. J. Thomson, by Prof. Ewing, and by Prof. Ascoli respectively in three different forms, all of which lead to the same results when applied to closed cycles, but differ in the values they give for the work done in an open transformation. An interesting examination of these formulæ is given by Signor Guido Grassi in the *Rendiconto* of the Naples Academy, vi. 7. The author finds that Ewing's formula $(1/4\pi)\int H dB$ represents the general expression of the total work of magnetisation; that $\int H dI$ represents the difference between the total work of magnetisation and the work which would have to be expended in order to create the magnetic field if the latter did not contain any bodies of magnetic permeability different to that of air; and that the expression $\int I dH$ does not represent the work of magnetisation except in the case of a closed cycle.

Prof. B. O. Peirce and Mr. R. W. Willson have for several years been engaged in an attempt to measure, by the aid of the "Wall method," the thermal conductivities of certain relatively poor conductors, and the variations of these conductivities with the temperature. The methods they have adopted, and the results of a number of observations, are now published in the *Proceedings* of the American Academy of Arts and Sciences (vol. xxxiv. No. 1, August 1898). In the present paper the results are given of determinations of conductivities of about twenty specimens of marble of different kinds, when the faces of slabs of the material are kept at temperatures of about 18° C., and 45° C., compared with the conductivity of a special brand of glass which appeared to be practically constant within the limits of the measurements. It appears that the conductivity of a specimen of marble at ordinary mean temperatures may depend, to the amount of several per cent., as

Messrs. Hershell and Lebour have shown, upon the amount of moisture which the specimen holds. An accuracy of only one per cent. is therefore claimed for the determinations. The absolute conductivities of the marbles, calculated on the assumption that the conductivity of the standard glass was 0·00277, are between 0·00501 and 0·00761. Special attention is drawn to two groups of fine-grained marbles, which have conductivities of about 0·0068 and 0·0076 respectively, at about 30° C.

THE principal facts referring to the origin of the metamorphosis of insects are summarised by Mr. J. W. Tutt in the volume of *Transactions* just issued by the South-Eastern Union of Scientific Societies (Taylor and Francis). Metamorphosis, he concludes, appears to be an adaptive habit which certain insects have adopted, in their struggle for existence against those enemies by which they are everywhere surrounded, and against those animals that compete against them for food. The habit of flying, by which they are able to escape from numberless enemies that have not this power, was probably one of the first factors in their development that led to their ultimate success. The additional ability to store up food in the early active (larval) stages of their existence so as to allow them to adopt a hiding habit and quiescent external form at the most critical period of life, must, however, have been the proximate cause of that success which has culminated in their being numerically the most successful types of terrestrial life in existence, the number of species being almost incredible.

WRITING with reference to the account of the resuscitation of a toad taken from a snake, which appeared in NATURE of August 11 (p. 344), a correspondent in the Purneah district, India, informs us that similar occurrences are common in parts of India. He remarks:—"Almost any snake can be made to disgorge what he has just eaten if worried a bit, and on numberless occasions I have seen this done with grass snakes, and seen a toad or frog, generally the latter, hop away rejoicing.... Snakes when angry or alarmed apparently have the power of throwing up their food, and only the other day I caught a 'dhamin,' a harmless but very savage snake—a small one, about 40 inches long—and put him in a box with a glass lid. The next morning I found two half-digested rats which the snake had thrown up. The same thing happened once with a black cobra, whose meal had also consisted of two rats with the addition of a sparrow."

A VOLUME of *Transactions and Proceedings* (vol. xxx., 1897) of the New Zealand Institute, edited and published under the authority of the Board of Governors of the Institute by Sir James Hector, K.C.M.G., F.R.S., has been received. Several of the papers in it have already been referred to; and the limitations of available space prevent us from referring to more of the present volume than a presidential address by Mr. W. T. L. Travers on material and scientific progress in New Zealand during the Victorian Era. Sir James Hector's work in New Zealand justly entitles him to distinction among the explorers and discoverers who have advanced the knowledge of the physical characteristics of the globe during the past sixty years. He commenced his duties as geologist to the Provincial Government of Otago in 1861, and under his direction very valuable investigations were made. Mr. Travers points out, however, that geological work in the field practically ceased in 1893, since which date Sir James Hector has not been provided with the necessary staff for pursuing it. Why this is the case is not clear, but the interruption in the work of one of the most important scientific departments of the Colony is much to be regretted.

REFERRING to the biological interests of the islands of New Zealand, Mr. Travers remarks, in the address referred to, that though the reptilian life found is very limited in extent, it contains two forms of the most remarkable character—namely, the *Tuatara* lizard and a frog known as *Leiopelma hochstetteri*, found chiefly in the Coromandel district. The lizard is only now found in some of the outlying islands, where its continued existence is threatened by the introduction of the pig and the cat. The affinities and structure of this reptile have been the subject of many memoirs, both by New Zealand and foreign naturalists, who have shown that it is evidently connected with some of the most ancient fossil forms. The frog is remarkable chiefly as occurring in an oceanic island. It is satisfactory to know that the fauna and flora of New Zealand have been, and are, studied by many collectors and investigators, the results of whose work have been embodied either in separate volumes or manuals published by the Government under the editorship of Sir James Hector, or in the shape of memoirs in the *Transactions* of the New Zealand Institute, such as those in the volume lately issued.

THE age of Niagara Falls, as indicated by the erosion at the mouth of the gorge, was the subject of a paper by Prof. G. Frederick Wright, read at the recent Boston meeting of the American Association. The late Dr. James Hall early noted the significant fact that "the outlet of the chasm below Niagara Falls is scarcely wider than elsewhere along its course." This is important evidence of the late date of its origin, and it has been used in support of the short estimates which have been made concerning the length of time separating us from the Glacial period. A close examination made by Prof. Wright this summer greatly strengthens the force of the argument, since he found that the disintegrating forces tending to enlarge the outlet and give it a V-shape are more rapid than has been supposed. As the result of his investigations, he concludes that a conservative estimate of the rate of disintegration for the 70 feet of Niagara shales supporting the Niagara limestone would be one inch a year, with a probable rate of two inches a year. But at the lowest estimate no more than 12,000 years would be required for the enlargement of the upper part of the mouth of the gorge 1000 feet on each side, which is very largely in excess of the actual amount of enlargement. Some of the recent estimates, therefore, which would make the gorge from 30,000 to 40,000 years old, are regarded as extravagant. According to Prof. Wright, the age of the gorge cannot be much more than 10,000 years, and is probably considerably less.

DR. AD. STRUCK, of Salonica, contributes an interesting paper on the Macedonian Plain to the issue of *Die Natur* for October 9. Some details of the mean temperature and rainfall are given, and a short account of the chief products of the region.

THE *Bollettino* of the Italian Geographical Society for October contains a paper, by M. Baratta, on the geographical distribution of earthquakes in Umbria. All the authentic records in existence are summarised and discussed, and a map showing the chief regions of seismic disturbance is appended.

WE have received a copy of the double number of *Spelunca*, the organ of the French *Société de Spéléologie*, for the first half of the current year. This journal is now in the fourth year of its existence, and it continues to publish valuable papers on subjects connected with caves and other subterranean structures. The present number contains some notes of interest on the protection of sources of potable water, indicative of increased attention to this matter in France.

A PAPER, by Prof. Dr. J. Walther, on historical and geological aspects of the problem of the course of the Oxus, appears in *Petermann's Mittheilungen*. Dr. Walther shows that the Oxus has always flowed into the Sea of Aral, and that the belief that its waters reached the Caspian arose from ignorance of the

existence of the Sea of Aral, and from the credit given to the fanciful reports of the English merchant Jenkinson, who travelled from Astrakhan to Bukhara in 1558.

A COPY of the general report of the work carried on by the Geological Survey of India for the period from January 1, 1897, to April 1, 1898, has been received. The headquarter notes, forming the first part, announce amongst other things the removal of the offices of the department to a new building which affords improved accommodation, but the Director pleads for transference of headquarters to a hill station. The second half of the report gives short accounts of nine separate surveying expeditions, including one on the north-west frontier by Mr. H. H. Hayden, who was permitted to accompany the Tirah Expeditionary Force.

THE September number of the *National Geographic Magazine* contains papers on the growth of the United States, by W. J. McGee; on the Bitter Root Forest Reserve, by Richard U. Goode; on Atlantic Estuarine tides, by M. S. W. Jefferson; and on the forest conditions of the State of Washington, by Henry Gannett. Mr. McGee's paper traces the growth of the States in area, population, wealth, railway-mileage, and carrying trade since 1790, and shows that the history of the growth of the United States is one of unequalled progress in all these elements, but, above all, in "development of a national character in which individual enterprise and capacity are the most conspicuous traits."

FOUR new parts of the second edition, revised, of "An Illustrated Manual of British Birds," by Mr. Howard Saunders, have been received from Messrs. Gurney and Jackson. Twelve parts of the work have now been published, and eight more have yet to appear to complete the work.

A RICHLY illustrated book for nature lovers is "An Elementary Botany" by Prof. George F. Atkinson, of Cornell University, announced for early publication by Messrs. Henry Holt and Co. Among the more than five hundred pictures are many full-page landscapes in half-tone.

MESSRS. ARCHIBALD CONSTABLE AND CO. will publish, early in November, "The Life of the late Sir Charles Tilston Bright, C.E., M.P.," wherein is included the story of the first Atlantic cable, the first telegraph to India and the Colonies, and the early land telegraphs of the United Kingdom. This work is written by Mr. E. B. Bright and Mr. Charles Bright, brother and son respectively of the subject of the memoir. The book, which contains many full-page and text illustrations, as well as photogravure plates, maps, charts, &c., will be published in two volumes.

UNDER the title of *Sell's Commercial Intelligence* a weekly newspaper has been started with the object of publishing authentic commercial intelligence, and developing British trade. The periodical will do a useful service to British industry if it will show our manufacturers how technical education and scientific research abroad have enabled other nations to beat us in the markets of the world. The following note on a decrease in the exports of chemicals is interesting in this connection :—"The American Consul at Liverpool points out that the exportation of chemicals from the Liverpool districts to the United States, has fallen from about nine million dollars in 1891 to a little under four million dollars in 1897, and at the present rate the exportations for 1898 will only amount to about a quarter of a million dollars. He comments on the application of electrolysis to chemical manufactures, and points out that where electricity can be produced by water-power, as at Niagara and many other places in the United States, the new process will have a better chance of success than in England." We are glad to see that a series of equivalents of British and metric measures is commenced in the new journal.

THE additions to the Zoological Society's Gardens during the past week include a Drill (*Cynocephalus leucophaeus*) from West Africa, presented by Mr. Alfred J. Dempster; two Wild Canaries (*Serinus canarius*) from the Canary Islands, presented by Mr. W. H. S. Quintin; two Tarantula Spiders (*Mygale*, sp. inc.) from the West Indies, presented by Mr. H. R. Taylor; a Common Hamster (*Cricetus frumentarius*), European; a Matamata Terrapin (*Chelys fimbriata*) from Brazil, deposited; a Blue Jay (*Cyanocitta cristata*) from North America, a Naked-throated Bell-bird (*Chasmorhynchus nudicollis*) from Brazil, a Common Boa (*Boa constrictor*) from South America, purchased; two Cockateels (*Calopsitta novae-hollandiae*), a Graceful Ground Dove (*Geopelia cuneata*), a Spotted Turtle Dove (*Turtur suratensis*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

NEW ALGOL VARIABLE.—A Kiel Circular (No. 14) tells us that Mr. Sawyer has discovered a new variable of the Algol type $+ 12^\circ$ 3557. Its period is very short, amounting to 0·89 days; the change in magnitude during this interval being 7·0 to 7·5. A minimum occurred on October 3·54 last, Greenwich mean time.

COMET BROOKS.—Kiel Circulars Nos. 13 and 14 give the elements of this comet as computed by Ristenpart and Möller on the one hand, and Hussey on the other. Those of the latter were computed from observations made on October 21, 23 and 25, and are as follows :—

T = 1898 November 23·14 Greenwich M.T.

$$\left.\begin{aligned} \omega &= 123^\circ\ 22' \\ \Omega &= 96\ \ 10 \\ i &= 140\ \ 19 \end{aligned}\right\} 1898{\cdot}0$$
$$q = 0{\cdot}7564$$

The ephemeris which accompanies these elements is only computed up to November 8, so we give below the position of the comet on that day for Greenwich midnight.

R.A. = 17h. 44m. 52s. Dec. = $+ 12^\circ\ 41'$.

The comet is rapidly decreasing in declination, and will be found in the region south of λ and δ Herculis, moving in the direction but slightly to the west of α Ophiuchi.

The Circular further states that the orbit of this new comet is similar to that of Comet 1881 IV. This latter was discovered by Schaeberle, and was visible to the naked eye for more than two weeks in August, its tail being over 10° long on August 21. Telescopically it was visible for a period of fourteen weeks.

THE ORBIT OF CASTOR.—Prof. Doberck, of the Hong Kong Observatory, has recently been investigating the elements of the orbit of Castor, or α Geminorum, as the components seem to have been behaving rather differently from what computation has destined them. The orbit, which was calculated in 1877, seems to have been entirely upset by the fact that since 1887 the components have been steadily approaching each other. With the assistance of Mr. J. I. Plummer, Prof. Doberck has collected all available observations and compared them with computed elements (*Astr. Nachr.*, 2168). From this he has formed the normal places, which have led him to obtain the following elements referred to the year 1900 :—

$$\Omega = 33^\circ\ 0' \qquad e = 0{\cdot}5909$$
$$\gamma = 69\ \ 34 \qquad P = 318{\cdot}23 \text{ years}$$
$$\lambda = 87\ \ 14 \qquad T = 1948{\cdot}86$$
$$a = 6''{\cdot}605$$

From these Prof. Doberck has calculated an ephemeris for the apparent places for the years 1900–1920, from which we make the following extract :—

t.	Pos. angles θ	Dist. ς	$\Delta\alpha$	$\Delta\delta$
	°	"	s	"
1900	225·65	5·644	−0·310	−4·04
1901	225·22	5·625	−0·312	−4·00
1902	224·78	5·603	−0·313	−3·95
1903	224·34	5·579	−0·314	−3·90
1904	223·89	5·554	−0·315	−3·85
1905	223·44	5·527	−0·315	−3·80

THE INTERNATIONAL CONFERENCE ON TERRESTRIAL MAGNETISM.

WE publish below the more essential parts of the Report of the Permanent International Committee on Terrestrial Magnetism. That report will, we believe, be submitted to the Committee of the International Meteorological (and Magnetic) Conference, to be held next summer in St. Petersburg, and may be referred by them to the full meeting of the Conference to be held in 1900 or 1901. The decisions arrived at will thus be fully considered on several occasions, and will probably command universal acceptance when they are finally approved.

It is unnecessary to discuss in detail the four points which were submitted to the Committee by the Paris Conference. Two of these refer to the form in which the observations made at observatories should be published. A third, based on a report by M. Mascart, is, no doubt, intended to crush the curious superstition, which still prevails, to the effect that the larger the magnet employed to measure the magnetic elements the more accurate will be the results attained.

The fourth point referred to the Committee was of more importance. The whole science of Terrestrial Magnetism is waiting for more accurate knowledge of the magnetic state of the earth in the tropics and the southern hemisphere. The Committee propose that temporary observatories shall be established at some dozen different places, most of which are easily accessible, and, if possible, maintained during a sun-spot cycle. This can only be done by international co-operation, and it is to be hoped that the scheme may be carried out before long; more especially as the report on which the resolution was founded was jointly prepared by General Rykatcheff and Prof. von Bezold, who hold high official scientific positions in Russia and Germany respectively.

The other papers read before the Conference were devoted to various subjects which fairly covered the whole range of the science.

Prof. Adams' account of his brother's calculations on the Gaussian constants, and Prof. Schuster's paper on a similar subject, led to the remark that the mathematics of the subject were at present far ahead of the accuracy of our knowledge of the facts to which they are to be applied.

The announcement made by Dr. Schott that a magnetic observatory was about to be established in Honolulu, the steps taken by the Prince of Monaco to found an observatory in the Azores, and the plucky start made by Dr. Beattie and Mr. Morrison in a magnetic survey of South Africa, were sufficient proof that efforts are being made to bring our experimental facts to the standard our mathematics have attained.

Local disturbances were dealt with in Sig. Palazzo's paper on the neighbourhood of Etna, and in Captain Creak's interesting statement as to the island of Funafuti. As our readers are aware, this is the coral island on which boring operations have been carried on for some time in order to test the rival theories of the origin of atolls. The magnet has to a certain extent anticipated the results to be obtained by the drill. Indubitable evidence has been found that the island is a centre of magnetic attraction, and the magnitude of the vertical disturbance indicates the presence of highly magnetic rock. It is, of course, possible that this may exist at a depth which no boring could reach; but the result is certainly of interest with reference to the problem which the boring is intended to solve.

Drs. van Rijckevorsel and Bemmelen announced that their elaborate survey of the Rigi had failed to establish any definite connection between the magnitude of the magnetic elements and height above the sea level. Earth currents were dealt with by Prof. Schuster and Dr. Lemström. Dr. Schmidt utilised the occasion to enforce the fact that isolated observations, made at irregular intervals, at ill-defined positions, are of little use in the determination of the secular change; while Dr. Eschenhagen pleaded for the co-operation of other observers in the simultaneous observation of the minute magnetic disturbances of which he is virtually the discoverer.

The Conference on the magnetic and electrolytic disturbances produced by electric railways was not well attended by electrical engineers, but the fact that Mr. Preece and Prof. Fleming were on the side of those who insist that these evils shall be dealt with while they are still in their infancy, gives hope that the bitter cry which is going up from directors of observatories, all the world over, will not be unheeded.

It only remains to add that the improvements in the organisation of the Permanent Magnetic Committee, which were advocated by the President in his opening address, were adopted by the Committee; and that the Magnetic Section of the International Meteorological Conference will probably in future be far more important than it has been in the past.

REPORT OF THE PERMANENT COMMITTEE ON TERRESTRIAL MAGNETISM AND ATMOSPHERIC ELECTRICITY TO THE INTERNATIONAL METEOROLOGICAL CONFERENCE.

Constitution of the Committee.

I. The Committee on Terrestrial Magnetism and Atmospheric Electricity appointed at Paris in September 1896, consisted of eight members. These gentlemen found that it was desirable to add to their number, by co-option, and the constitution of the Committee is now as follows:—

Appointed at Paris: Prof. Rücker (President), Prof. Eschenhagen, Prof. Liznar, M. Th. Moureaux, Sig. L. Palazzo, Dr. Paulsen, Dr. van Rijckevorsel, General Rykatcheff.

Co-opted: Dr. Bauer, Prof. W. von Bezold, Sig. Brito-Capello, Dr. Carlheim-Gyllenskjold, Prof. Mascart, Prof. T. Mendenhall, Prof. A. Schmidt, Dr. C. Schott, and Prof. A. Schuster.

The report then proceeds to give an account of the proceedings of the Conference at Bristol, which have been described in these columns.

II. Dr. C. H. Lees, of the Owens College, Manchester, and one of the Secretaries of the Section of Mathematics and Physics of the British Association, acted as Secretary of the International Conference and of the Permanent Committee.

Meetings of the Permanent Committee.

III. During the session of the British Association, the Committee also held meetings on September 7, 9, 12 and 13, at which the following resolutions were unanimously approved:—

(*a*) Matters referred to the Committee by the International Meteorological Conference.

Four questions were referred to the Committee.

The first of these was the following resolution of M. Dufour (Report of the Paris Conference, p. 30).

> "In calculating monthly means, all days are to be taken into consideration. It is left open to each Director to give, in addition, means calculated without taking disturbed days into account."

This was approved by the Committee with the substitution of the words "It is desirable" for the words "It is left open to each Director."

(1*a*) The Committee were also of opinion that the quiet days chosen by the Directors of the different observatories should be communicated to the President of the Permanent Magnetic Committee, and circulated by him, and also that it is desirable to inquire if it will be possible to select the same quiet days for the different observatories.

(2) The second resolution referred to the Committee was the following, proposed by Prof. von Bezold and M. Mascart (Report, p. 31).

> "It is desirable to publish the monthly means of the components X, Y, Z, and at least for the months of January and July, the differences dX, dY, dZ, of the hourly means from the preceding means."

In lieu of this the Committee adopted the following resolution:—

> "It is desirable to publish the monthly means of the Geographical Components of the Magnetic Force for each month, and also the differences between the hourly means for each month, and the monthly means for that month."

(3) The third resolution referred to the Committee was the following, proposed by General Rykatcheff (Report, p. 32).

> "It is desirable for the progress of Terrestrial Magnetism that temporary observatories should be installed in certain localities, especially in tropical countries."

On this subject a report had been prepared at the request of the President, by Prof. von Bezold and General Rykatcheff, of which a copy is appended.

After considering the report the Committee resolved:—

> "That it is desirable that temporary magnetic observatories should be established in places such as the following:—Taschkent, Peking, the Lick Observatory, Quito, Para, Colombo, Cape of Good Hope, St. Paul or N. Amsterdam, Honolulu, and Point Barrow or Sitka, or some other station in a high latitude in North America."

"That these observatories should, if possible, be provided with both absolute and variation instruments, of which the latter should be self-registering instruments, and should be established for at least seven, and if possible, for eleven or twelve years, *i.e.* for a complete sun-spot period."

The Committee were informed by Dr. C. Schott that it was the intention of the Coast and Geodetic Survey of the United States to establish a magnetic observatory at Honolulu.

In the course of the discussion on the above resolution, the Committee also resolved :—

(3*a*) "That it is desirable to point out that observatories at great distances from others should be provided with both absolute and self-registering variation instruments."

(4) The fourth matter referred to the Committee was the question as to the relative advantages of long and short magnets, raised by M. Mascart at the Paris Conference (Report, p. 39).

On this subject a report, of which a copy is appended, had been prepared, at the request of the President, by M. Mascart.

After considering this report, the Committee resolved :—

"Unless special reasons exist to the contrary it is desirable that the dimensions of the magnets should be as small as possible, provided that the accuracy of the results is adequately maintained."

(*b*) Resolutions passed by the Committee on matters arising during the International Conference.

(5) Prof. Eschenhagen made a statement to the Conference as to his recent investigations on minute disturbances made by very sensitive apparatus with a very open time scale.

In view of this statement, the Committee expressed their sense of the importance of the resolutions on this subject passed by the Paris Conference (Report, p. 35), and the hope that the principal observatories would carry out simultaneous observations of the character proposed.

M. Moureaux informed the Committee that preparations for such observations were already complete in the observatory at Parc St. Maur.

The Committee took note of the statement that Prof. Eschenhagen would be willing to give information as to the construction of the instruments used by him.

(6) The Committee also passed the following resolution :—

"The Committee is of opinion that the early establishment of a magnetic observatory at the Cape of Good Hope, provided with absolute and self-registering variation instruments, would be of the highest utility to the science of Terrestrial Magnetism, especially in view of the Antarctic expeditions which are about to leave Europe, and that the observatory should be established at such a distance from electric railways and tramways as to avoid all possibility of disturbance from them."

Directions were given that the proper steps should be taken to obtain the approval of the British Association for this resolution, with the request that, if approved, it should be forwarded to the Colonial Government.

(7) On the motion of Prof. Adolph Schmidt, the Committee resolved :—

"That it is desirable that magnetic observations taken in regions not included in a magnetic survey, should be repeated from time to time, care being taken to secure the identity of the point of observation."

(8) Prof. Eschenhagen was requested to draw up a detailed scheme for the exchange between the various observatories of the curves of the self-registering variation instruments taken during important magnetic storms, and to lay the scheme before the next meeting of the Conference.

(9) With reference to certain inquiries which Prof. Eschenhagen suggested should be addressed to the Directors of Magnetic Observatories, the Committee was of opinion that, although it would be outside the scope of their duties to make the inquiries, it was desirable that the information should be collected and published.

(10) After the discussion on the magnetic disturbances introduced by electric railways and tramways, the following resolution was adopted by the Committee :—

"The Committee are of opinion that any sensible magnetic disturbance produced in a magnetic observatory by electric railways or tramways, is seriously detrimental and may be fatal to the utility of the observatory. They consider that special precautions should be taken to prevent such disturbances, and append as an example the provisions for the protection of the Kew Observatory, inserted in a Bill passed by the British Parliament authorising the construction of an electric railway, the nearest point of which is to be at a distance of one kilometre from the observatory (Appendix II.)."

Future Organisation of the Committee.

(10) The Committee took into consideration their own future organisation, and passed the following resolutions :—

"It is desirable that terrestrial magnetism should continue to be within the scope of the International Meteorological Conference, provided that :—

(*a*) Invitations to attend that Conference are issued as widely as possible to Directors of Magnetic Observatories and to all students of Terrestrial Magnetism.

(*b*) That the Permanent Committee on Terrestrial Magnetism and Atmospheric Electricity, as established at the Paris Conference, be continued.

(*c*) That in future there shall be a magnetic section of the International Meteorological Conference, which shall elect, or otherwise share in the appointment of, a permanent Magnetic Committee.

(*d*) That the Magnetic Committee have power to summon an International Magnetic Conference at times other than those at which the whole of the International Meteorological (and Magnetic) Conference may meet."

The Committee also consider that the President of the Permanent Magnetic Committee should hold office between two successive meetings of the International Meteorological (and Magnetic) Conference.

(Signed) Arthur W. Rücker, *President.*

September 13, 1898.

Appendix II.

Clause for the protection of Kew Observatory.

(1) The whole circuit used for the carrying of the current to and from the carriages in use on the railway shall consist of conductors which are insulated along the whole of their length to the satisfaction in all respects of the Commissioners of Her Majesty's Works and Public Buildings (in this section called "the Commissioners"), and the said insulated conductors which convey the current to or from any of such carriages shall not at any place be separated from each other by a distance exceeding one hundredth part of the distance of either of the conductors at that place from Kew Observatory.

(2) If in the opinion of the Commissioners there are at any time reasonable grounds for assuming that by reason of the insulation or conductivity having ceased to be satisfactory a sensible magnetic field has been produced at the observatory, the Commissioners shall have the right of testing the insulation and conductivity upon giving notice to the Company, who shall afford all necessary facilities to the engineer or officer of the Commissioners or other person appointed by them for the purpose, and the Company shall forthwith take all such steps as shall in the opinion of the Commissioners be required for preventing the production of such field.

(3) The Company shall furnish to the Commissioners all necessary particulars of the method of insulation proposed to be adopted, and of the distances between the conductors which carry the current to and from the carriages.

APPLICATIONS OF ELECTRICITY.[1]

Lightning.

THE first practical application of the science of electricity was for the protection of life and property. Franklin in 1752 showed how to secure ourselves and our buildings from the disastrous effects of a lightning stroke. Very little has been done since to improve upon his plan. A Lightning-Rod Conference, upon which I served, met in 1878, and its report, published in 1881, remains an admirable and useful standard of reference. The principle advocated by Franklin was prevention rather than protection. If a building or a ship be fitted and maintained with good continuous copper conductors, making a firm electrical contact with the earth or the sea, and

[1] Abridged from an inaugural address delivered at the Institution of Civil Engineers, on November 1, by the President, Mr. W. H. Preece C.B., F.R.S.

be surmounted well up in the air with one or a cluster of fine points, all the conditions that determine a charge of atmospheric electricity and a flash of lightning are dissipated silently away and no terrible discharge is possible. A mischievous and baseless delusion is prevalent that protectors actually attract lightning and may be sources of danger. Every exposed building should be fitted, but a well-protected dwelling-house is the exception not the rule. Even when protectors are fixed apathy leads to their imperfect maintenance. Their failure to act is always traceable to the neglect of some simple rule. Carelessness is the direst disease we suffer from. Telegraph and telephone wires which spread all over our towns and country are very much exposed to the influence of atmospheric electrical effects. Every instrument is now protected. Every telegraph pole has a lightning conductor. Accidents are rare, and the system itself is a public safeguard. In some countries like California and South Africa thunder-storms are very frequent and very severe, but their effects have been tamed.

TELEGRAPHY.

In 1837 Cooke and Wheatstone showed how electricity could be practically used to facilitate intercommunication of ideas between town and town and between country and country. The first line was constructed in July of that year upon the incline connecting Camden Town and Euston Grove Station, the resident engineer being Sir Charles Fox, father of the senior Vice-President. Five copper wires were embedded in wood of a truncated pyramidal section and buried in the ground. The instrument used possessed five needles or indicators to form the alphabet. A portion of this original line was recently recovered *in situ*.

The pioneer line of 1837, 1½ miles long, has, during a period of sixty years, grown into a gigantic world-embracing system. The extent of the present system of British telegraphs is shown by the following table :—

	Miles of wire.
General Post Office and its Licensees ..	435,000
Railway companies	105,000
India and Colonies	387,966
Submarine cables	183,400
Total	1,111,366

The speed of signalling and the capacity of working have been increased sixfold, and wires can now be worked faster than messages can be handled by the clerical staff.

The form of submarine cable and the nature of the materials used in its construction have varied but very little since the first cable was laid in 1851. The recent invasion of our channels and seas by the *Limnoria terebrans*, a mischievous little crustacean which bores through the gutta-percha insulating covering, and exposes the copper conductor to the sea-water, leading to its certain destruction, has led to the use of a serving of brass tape as a defence. It has proved most effective.

No one has done more than Lord Kelvin to improve the working of submarine cables. His recording apparatus is almost universally employed on long cables. By the duplex method of transmission the capacity of cables has been practically doubled, and this has been still further improved by applying to cables the system of automatic working, which is such a distinguishing feature of our Post Office system. The number of electrical impulses which can be sent through any cable per minute is dependent upon its form, and is subject to simple and exact laws, but it varies with the quality and purity of the materials used. There is no difficulty in maintaining the purity of copper. Indeed, copper is frequently supplied purer than the standard of purity adopted in this country—known as Matthiessen's standard. The purity of gutta-percha is, however, questionable. The supply of this dielectric has dwindled ; it has failed to meet the demand ; its cultivation has been neglected. The result is a dearth of the commodity, a great increase in price, and its adulteration by spurious gums. India-rubber, its sole competitor for cables, is being absorbed for waterproof garments and pneumatic tyres, but for underground purposes paper is being used to an enormous extent. Paper has the merit, when kept dry, not only of being an admirable insulator, but of being very durable. There is paper in existence in our libraries over 1000 years old. The difficulty is to keep it dry. This is one of the problems the engineer delights to consider. He has been most successful in obtaining a solution. The lead-covered paper cables, which are being laid in the streets of all our great cities, are admirable. I am laying one of seventy-six wires for the Post Office telegraphs between London and Birmingham, and the Cable Companies are contemplating leading their long cables from Cornwall up to London, so as to be free from the weather troubles of this wet and stormy island.

It is impossible to forecast the future of telegraphy. New instruments and new processes are constantly being patented, but few of them secure adoption, for they rarely meet a pressing need or improve our existing practice. The writing telegraph originating with our late member of Council, E. A. Cowper, which reproduced actual handwriting, much improved by Elisha Gray, and called the "Telautograph," is steadily working its way into practical form, and electrical type-writing machines of simple and economical form are gradually replacing the A B C visual indicator. The introduction of the telephone is revolutionising the mode of transacting business. There seems to be a distinct want of some instrument to record the fleeting words and figures of bargains and orders transmitted by telephone. Hence a supplement to that marvellous machine is needed. The telautograph and electrical type-writer will fill this want. Visions of dispensing with wires altogether have been fostered by the popularity of Marconi's "wireless telegraphy" ; but wireless telegraphy is as old as telegraphy itself, and a practical system of my own is now in actual use by the Post Office and the War Department.

TELEPHONY.

I was sent, in 1877, together with Sir Henry Fischer, to investigate the telegraph system of the American continent, and especially to inquire into the accuracy of the incredible report that a young Scotchman named Bell had succeeded in transmitting the human voice along wires to great distances by electricity. I returned from the States with the first pair of practical instruments that reached this country. They differed but little from the instrument that is used to-day to receive the sounds. The receiver, the part of the telephone that converts the energy of electric currents into sounds that reproduce speech, sprang nearly perfect in all its beauty and startling effect, from the hands of Graham Bell. But the transmitting portion, that part which transforms the energy of the human voice into electric currents, has constantly been improved since Edison and Hughes showed us how to use the varying resistance of carbon in a loose condition, subject to change of pressure and of motion under the influence of sonorous vibrations. The third portion, the circuit, is that to the improvement of which I have devoted my special attention. Speech is now practically possible between any two post-offices in the United Kingdom. We can also speak between many important towns in England and in France. It is theoretically possible to talk with every capital in Europe, and we are now considering the submersion of special telephone cables to Belgium, Holland, and Germany.

RAILWAYS.

The employment of electricity in the working of railways has not only been highly beneficent in the security of human life, but it has vastly increased the capacity of a road to carry trains. The underground traffic of the metropolis is conducted with marvellous regularity and security, though the trains are burrowing about in darkness and following each other with such short intervals of time, that the limit of the line for the number of trains has been reached. Electric traction is going to extend this limit by increasing the acceleration at starting and improving the speed of running. It will also reduce the cost of working per train-mile, so that the advent of electricity as a moving agency is certain to prove highly economical. What it will do as a remover of bad smells and foul air and for personal comfort cannot be estimated. Time alone will enable us to assess the intrinsic value of public satisfaction acquired by the change.

DOMESTIC APPLIANCES.

The introduction of electricity into our houses has added materially to the comfort and luxury of home. If we were living in the days of ancient Greece, the presiding domestic deity would have been *Electra*. The old bellhanger has been rung out by the new goddess. Electra has entered our hall-door, and attracts the attention of our domestics, not by a gamut of ill-toned and irregularly-excited bells, but by neat indicators and one uniform sound. The timid visitor fears no more that he has expressed rage or impatience by his inexperience of the mechanical pull required at the front door. The domestic telephone is coming in as an adjunct to the bell. Its

use saves two journeys. The bell attracts attention, the telephone transmits the order. Hot water is obtained in half the time and with half the labour. Fire and burglar alarms are fixed to our doors and windows; clocks are propelled, regulated and controlled. Even lifts are hoisted for the infirm and aged. Ventilation, and in warmer countries coolness, are assisted by fans. Heating appliances are becoming very general where powerful currents are available. Radiators assist the coal fire by maintaining the temperature of a room uniform throughout its length and breadth. Ovens are heated, water is boiled, flat-irons become and are maintained at a useful temperature, breakfast dishes and tea-cakes are kept hot, even curling-tongs have imparted to them the requisite temperature to perform their peculiar function.

Electric Light.

But it is in supplying us with light without defiling the air we breathe in our dwellings with noxious vapour, that electricity has proved to be a true benefactor to the human race. The Legislature has facilitated the acquisition by municipalities of those local industries that affect the welfare of the whole community, such as road-making, sewerage, the supply of water, tramways, and, above all, electric light.

It is on board ship that electric light has been pre-eminently successful, and where it filled such a crying want that its introduction met with no check. It was almost immediately and universally adopted. Search lights, prompted by the great development of the torpedo, were introduced into our Navy as early as 1875 by Mr. Henry Wilde. The first ship to be fitted with internal electric lighting was the *Inflexible* in 1882. In 1884 the Admiralty ordered it to be applied to all H.M. warships. The first application of electrical power was in the case of H.M.S. *Barfleur*, where motors were used for working guns and for the supply of ammunition. It has subsequently been partially extended to the working of gun-turrets, ventilating fans, capstans, and boat-hoisting gear; but hydraulics, the child of our venerable Past-President, Lord Armstrong, is the form still more generally preferred and used for power in our Navy, though other nations make a much more extended use of electricity. The technical reports received by the United States Navy Department indicate that the electrical appliances on their warships worked very successfully during the recent war.

Lighthouses.

The introduction of electricity into our lighthouses has not been such an unqualified success as into our ships. No new electric light has been installed on the coast of Great Britain since St. Catherine's (Isle of Wight) was fitted up in 1888. Other electric lamps are to be found at the South Foreland, at the Lizard, and at Soutar Point, only four lighthouses in all upon our coasts.

This is due chiefly to the great prime cost of its installation and to the annual expense of its maintenance. But the sailor himself is not enamoured of it. It does not assist him in judging distances. It is too brilliant in clear weather, while in bad weather it penetrates a fog no further than an ordinary oil lamp. Moreover, great modern improvements have rapidly followed each other in other apparatus, lenses and lamps. A third order light of to-day can be made superior to a first order light of ten years ago. Oils have improved and gas has been introduced. Lord Kelvin proposed that lighthouses should signal their individuality to passing ships by flashing their number in the Morse alphabet. But the Morse alphabet, in 1875, was as unknown as Egyptian hieroglyphics to our nautical authorities. The same end was obtained with less mental exertion by occulting and group-flashing systems.

A new and very promising plan has recently been introduced in France, called the "Feux-éclairs" or "lightning flash" system. It has been installed in many places, but especially at the two Capes dominating the Bay of Biscay. Nothing more brilliant or more effective is to be seen anywhere than the lights that rapidly sweep across the horizon, like well-directed flashes of summer lightning, with a motion that conveys the idea of a wave of some illuminated spirit-arm warning the navigator away from the rocky dangers of Ushant.

Our Trinity House has not yet introduced this plan. Any change of our well-considered and deeply-important coast-lightning system is not to be hastily effected. We are very proud of our well-guarded shores. Every headland and land-fall, every isolated rock, all dangerous shoals and banks and narrow channels in lines of trade are so illuminated that navigation by night is as safe and easy as by day. Lighthouses and lightships stud our channels. Most of them are placed in direct communication with our Post Office telegraph system, so that the speediest help can be secured in moments of difficulty and danger.

We, however, want improvement in fogs and storms. Here electricity steps in. I wrote, in 1893, of wireless telegraphy:— "These waves are transmitted by the ether; they are independent of day or night, of fog or snow or rain, and, therefore, if by any means a lighthouse can flash its indicating signals by electro-magnetic disturbances through space, ships could find out their position in spite of darkness and of weather. Fog would lose one of its terrors, and electricity become a great life-saving agency." We are nearing that goal.

Traction.

Electrically worked railways originated in Europe. The first experimental line was constructed by Dr. Werner Siemens in Berlin in 1879. When I visited America in 1884 there was only one experimental line at work in Cleveland, Ohio. Now there are more miles of line so worked in Cleveland alone than in the whole of the United Kingdom. The reason for this is not difficult to comprehend. The climatic influences of the States, the habits of the people, the cost of horseflesh, the necessity for more rapid transit, soon proved the vast superiority of electric over every other form of traction. Horses and cables will soon disappear. The successful progress in the States and on the Continent has proved contagious, and everywhere our great cities are rising to the occasion. The relative merits of overhead and underground conductors, and the use of storage batteries, are practically the only important engineering questions under discussion. The underground conduit system has been materially helped by the practical object-lesson to be seen in New York, where the tramways are being very successfully worked on this plan. The trolley system is much more economical. Its erection does not interfere with the traffic of the streets. The principal objection to it is its anti-aesthetic appearance, but it is wonderful how ideas of utility and the influence of custom make us submit to disfigurement. What is more inartistic than a lamp-post, or more hideous than the barn-like appearance of many a railway terminus?

The corrosion of water- and gas-pipes, the disturbances of telegraphs and magnetic observations, are serious questions arising from the introduction of powerful currents into the earth, but fortunately the remedies are simple, easily attainable, and very effective.

I have alluded to the proposed working of our underground railways. The success of the Mersey Dock line, and of the South London and Waterloo lines, have placed the question beyond controversy. The problem to be solved is how is the conversion from steam to electricity to be effected without interfering in any way with the existing traffic or with the existing permanent way? This is not to be solved on paper. It must be determined by actual trial, and this is about to be done on the short line connecting Earl's Court and High Street, Kensington. Electric traction as an economical measure in all cases of dense traffic is so certain that every great railway company must consider, sooner or later, the working of their surburban traffic by electricity. This experiment on the Metropolitan Underground Railways, therefore, should interest them all. It is a question deeply affecting the interests and comfort of the public and the condition of the congested traffic of our streets.

The storage battery fulfils a very important function in the economical working of an electric railway. It equalises the pressure on the circuits. It meets the fluctuations of the load. It takes in current when the load is light; it lets out current when the load is heavy. It thus secures the continuous working of the engines at their full constant and most economical conditions, and it enables the engines to be shut down altogether when the load is very light, as it is at night, in the early morning, and on Sundays.

In Buffalo the battery is charged by energy from Niagara, twenty-one miles away, and the local engines are shut down for twelve hours every day, and for ten hours on Sunday.

Electro-Chemistry.

The transference of electricity through liquids is accompanied by the disintegration of the molecules of the liquids into their constituent elements. The act of conduction is of the nature of

work done. Energy is expended upon the electrolyte to break it up, and the quantity thus chemically decomposed is an exact measure of the work done. Every electrolyte requires a certain voltage to overcome the affinity between its atoms, and then the mass decomposed per minute or per hour depends solely upon the current passing. The process is a cheap one and has become general. Three electrical HP. continuously applied deposit 10 lbs. of pure copper every hour from copper sulphates at the cost of one penny. All the copper used for telegraphy is thus obtained. Zinc in a very pure form is extracted electrolytically from chloride of zinc, produced from zinc blende, in large quantities. Caustic soda and chlorine are produced by similar means from common salt. The electroplating of gold, silver and nickel is a lucrative and extensive business, especially in Birmingham and Sheffield. Gold and silver are refined by this electrolysis in Russia, and nickel in the United States. Sea-water is decomposed in this way for disinfecting purposes by the Hermite process.

The passage of electricity through certain gases is accompanied by their dissociation and by the generation of intense heat. Hence the arc furnace. Aluminium is thus obtained from cryolite and bauxite at Foyers by utilising the energy of the Falls. Phosphorus is also separated from apatite, and other mineral phosphates. Calcium carbide, obtained in the same way, is becoming an important industry.

It is remarkable that our coalfields have not been utilised in this direction. Electrical energy can be generated on a coal-field, where coal of good calorific value is raised at a cost of 3*s.* per ton, cheaper than by a waterfall, even at Niagara.

Electro-metallurgy is now a very large business, but it is destined to increase still more, for the generation of electrical energy is becoming better understood and more cheaply effected.

The Transmission of Power.

The energy wasted in waterfalls is enough to maintain in operation the industries of the whole world. Great cities as a rule are not located near great falls; nor has a beneficent Providence provided great cities with waterfalls as, according to the American humourist, He has with broad rivers. There is but one Niagara, and we are seeing how industries are rather going to the falls than the energy of the falls is being transmitted to the industrial centres. The arbitrament of money is limiting the distance to which energy can be profitably transmitted. The Cataracts of the Nile can be utilised in irrigating the waste lands of the upper regions of the river, but their energy cannot compete, at Alexandria, with that of coal transported in mass from England.

At Tivoli, fifteen miles across the Campagna, the energy of the falls are economically utilised to light Rome and to drive the tramways of that city. The electric railways at Portrush and Bessbrook, in Ireland, are worked by water-power, and Worcester, Keswick and Lynton use it in this country, but on a very small scale. It is not used more, for the simple reason that there are no more falls to use. Water-power is used very extensively in Switzerland, because it is so abundant there, and in our Colonies, especially in South Africa; but it is in the United States, especially in Utah and California, where the greatest works have been installed especially for the transmission of energy to mines.

In mines electricity is invaluable. It is used for moving trams and for working hoists. It lights up and ventilates the galleries, and by pumping keeps them free of water. It operates the drills, picks, stamps, crushers, compressors, and all kinds of machinery. The modern type of induction motor, having neither brushes nor sliding contacts, is free from sparks and safe from dust. Electrical energy is clean, safe, convenient, cheap, and it produces neither refuse nor side products. It is transmitted to considerable distances. In mountainous countries the economical distance is limited by the voltage which insulation can resist; 40,000 volts are being practically used between Provo Canyon and Mercur, in Utah, in transmitting 2000 horse-power thirty-two miles.

Conclusion.

I have touched lightly—I fear too lightly—upon some of the applications of electricity. I have confined myself, in a very general sense, to those with which I have been personally associated. I have shown how electricity began its beneficent career by protecting our lives and property from the disastrous effects of nature's dread artillery, how it facilitates intercommunication between mind and mind by economising time and annihilating space. It

> "Speeds the soft intercourse from soul to soul,
> And wafts a sigh from Indus to the Pole."

By its metallic nerves it brings into one fold not only the scattered families of one nation, but all countries and all languages, to the manifest promotion of peace and general good will. Not only does it show us how to utilise the waste energies of nature, but it enables us to direct them to the place where they are most wanted and to use them with the greatest economy. It opens to our view nature's secret storehouses, presenting us with new elements, new facts and new treasures. It economises labour and purifies material. It lightens our darkness in more senses than one, and by enabling us to see the unseen, it tends to aid the gentle healing art and to alleviate both suffering and pain. It aids us in the pursuit of truth, and it has exploded the doctrine that the pursuit of truth means the destruction of faith.

RECENT CORAL BORING OPERATIONS AT FUNAFUTI.

The subjoined extract from the *Sydney Daily Telegraph* of September 9, containing particulars as to the coral-boring operations at Funafuti, has been sent to us by a correspondent:—

News has just been received *via* New Zealand, through the U.S.S. Co.'s steamer *Poherua*, which coaled H.M.S. *Porpoise* at Funafuti, as to the progress of the two bores, one on land, and the other in the lagoon of that coral atoll. With regard to the lagoon bore, operations were commenced on August 15, Commander Sturdee having succeeded in mooring the war-ship so taut that it was possible to work the boring pipes without risk of their bending or breaking from the bows of the war-ship. Mr. G. H. Halligan, who is in immediate charge of the boring plant, reports that for the first twenty-four hours of boring a depth of 109 feet was attained, the total depth of the bore being 212 feet below the water level of the lagoon, the depth of water to the bottom of the lagoon being 103 feet. The *Poherua* left at the end of the first day's boring. As regards the nature of the material bored, Mr. Halligan states that the first 80 feet below the bottom of the lagoon were formed of sand, composed of joints of Halimeda (a seaweed which secretes a jointed stem of lime) and of fragments of shells. The remaining 29 feet were in similar material, but containing small fragments of coral getting larger at the deeper levels.

This is a record rate of boring, and considering the difficulty of holding the war-ship at her moorings absolutely steady, in spite of wind and tide, is a wonderful performance. The whole undertaking may be looked upon as a success from a scientific standpoint, even if no greater depth than 109 feet be ultimately reached. As, however, there was still nearly a week available for further boring, it is hoped that before the war-ship has to leave Funafuti, the bore may have been considerably deepened. This is probably the first bore that has ever been made in the bottom of the lagoon of a coral atoll.

The deepening of the old bore, discontinued last year at a depth of 698 feet, on the main island of Funafuti, has been proceeding slowly but steadily. The party were landed there by the London Missionary Society's steamer *John Williams*, on June 20 last. As was anticipated, little difficulty was experienced in re-driving the lining pipes into the old bore, and washing out the sand and rubble which had choked the bore-hole. Pipes were laid from the site of the old bore to some small water-holes from which a supply of fresh water was obtained for the boiler. By July 25, the re-lining and cleaning of the old bore having been successfully accomplished, boring was resumed, and up to the time when the steamer *Poherua* left, a depth of 840 feet had been reached. The bore last year terminated in soft dolomite limestone at 698 feet, but it has now been ascertained that below this is a hard rock, so hard that the portion of the bore-hole which penetrates it no longer needs to be lined with iron pipes, a condition which must facilitate the work of boring.

Mr. A. E. Finckh reports that this hard rock is largely composed of corals and shells. This depth of 840 feet is exactly the crucial depth which it was hoped the bore might reach, and if possible exceed, as at a corresponding depth on the ocean face of the reef there is a strongly marked shelf, as shown by the soundings by Captain A. Mostyn Field, of H.M.S. *Penguin*,

and it is considered that this shelf, at the 140 fathoms level, marks the downward limit of the coral formation.

Exceptionally dry weather has been experienced, which has somewhat delayed the boring, on account of the temporary failure of the water-hole from which the water supplies were being drawn. Foreman Symons, however, who is in charge of the drill, had, by extending the line of suction pipes, been able to tap a second water-hole, from which water was being pumped to the boiler. Mr. Finckh's experiments on the rate of growth of the various reef-forming animals and plants were progressing satisfactorily. It was hoped that the bore would, in about eight weeks' time, reach the total depth of 1200 feet, which is the maximum depth contemplated. Further information may be expected shortly upon the return from Funafuti of H.M.S. *Porpoise*, which will convey all the core hitherto obtained from Funafuti, and tranship it to Sydney; and until the core has been subjected to thorough microscopic and chemical examination it would, of course, be premature to attempt to forecast the exact trend of the evidence. The results so far obtained are very satisfactory.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Langley, F.R.S., has been elected a member of the Council of the Senate in the place of Principal Glazebrook, now of Liverpool University College.

Lord Wolsingham, the High Steward, has generously offered a second (bronze) medal for specially meritorious essays in biology which do not succeed in winning the Wolsingham gold medal.

At the matriculation on October 21 last, 897 students joined the University. These included 19 "advanced students" admitted to post-graduate research or other advanced work. The total entry for the year 1898 is thus brought up to 944, which is the highest since 1890.

An animated discussion on the proposed Sedgwick Memorial Museum took place in the Arts School on October 22. Two plans, a larger and a smaller, were before the Senate. The geological staff strongly pressed that the larger should be adopted, though it appeared that it would cost some 44,000*l*. Of this the Memorial Fund would contribute 27,000*l*.

Mr. R. S. Morrell, who was placed in the first class in both parts of the Natural Sciences Tripos in 1888-90, and Mr. J. S. Gardiner, who was similarly placed in 1893-95, have been elected to Fellowships at Gonville and Caius College.

ON Wednesday, October 26, Sir William Harcourt opened the new central block of Aberystwith University College, erected at a cost of about 20,000*l*., towards which sum he, when Chancellor of the Exchequer, gave a grant of 10,000*l*. Speaking subsequently at a luncheon, Sir William Harcourt referred to the unsatisfactory state of secondary or intermediate education in England, and said that what was required was a system of intermediate education similar to that which has been established in Wales, to connect the elementary schools with the universities.

SPEAKING at University College, Liverpool, on Friday last, Sir J. Gorst, Vice-President of the Committee of Council on Education, said that at the present time there was a strong desire on the part of all interested in education that a great step forward should be made in commercial and technical instruction. The necessity arose from industrial competition in foreign countries. Undoubtedly our higher and elementary education for industrial purposes was vastly inferior to that of many of our rivals, and no time was to be lost in setting to work to effect an improvement. To this forward step there were two essential conditions. In the first place, elementary education must be improved, for it was no use to attempt to organise a system of higher schools without having a sound elementary basis upon which to build. Moreover, it was essential that higher education should be perfectly organised, and that in each educational area there should be one clear and definite plan of education suitable to the particular conditions of the place.

THE report on the work of the Examinations Department of the City and Guilds of London Institute for the session 1897-98 has been published. From it we learn that the number of technical classes throughout the country registered by the Institute shows a marked increase, and the instruction is in closer touch with industrial requirements. The recognition by the Post Office of the Institute's certificate in telegraphy as qualifying the holder of it for increased remuneration has had the effect of nearly doubling the number of candidates for examination in that subject, and shows the influence, which employers generally might exercise, in encouraging attendance at technical classes, by giving some kind of reward to such of their employés as succeed in passing the Institute's examinations. County Councils have during the past year further availed themselves of the services of the Institute in connection with the technical classes under their control. Several important additions and alterations have been made in the programme of Technological Examinations.

THE Calendar of the University College of North Wales (which is a constituent College of the University of Wales) for the year 1898-99, has been published. The syllabus of classes shows that students are educated as well as instructed at the College, and the questions set in the science subjects in which candidates for entrance scholarships have been examined, give evidences that no credit is gained by perfunctory work or for information derived entirely from books. The College offers a course of training to those who intend to become teachers in secondary or intermediate schools, and in this, as in other subjects, the course involves practical as well as theoretical work. Among the subjects to be dealt with in the lectures are the psychology of the growing mind, and physiology and hygiene in their relation to school life. The agricultural department, and the College Farm, have recently been referred to (p. 611). After following a course of study at the College extending over three years, students may take the degree of Bachelor of Science of the University of Wales in the group "Agriculture and Rural Economy."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 24.—M. Wolf in the chair.—On double integrals of the second species in the theory of algebraic surfaces, by M. Émile Picard.—Properties of calcium, by M. Moissan. The pure crystallised calcium whose properties are given in this paper, was prepared by the method already described in NATURE. The melting point, determined by a thermo-couple, was found to be 760° C. The metal can be cut, but it is much less malleable than sodium or potassium, as it can be broken, and shows a crystalline fracture. When totally free from nitride, its colour is brilliantly white, recalling that of silver. The density was found to be about 1·85; and it is hard enough to scratch lead, but not calcium carbonate. Neither chlorine, bromine, nor iodine attacks calcium in the cold, although the corresponding haloid salts are formed at higher temperatures. Calcium burns brilliantly in oxygen, the temperature resulting from the combustion being so high that a part of the quicklime produced is melted and volatilised. When burnt in air, the calcium combines with both constituents together, nitride and oxide being simultaneously formed. At a dull red heat the metal also combines with carbon with great energy, forming CaC_2. At high temperatures the reducing power of calcium is remarkable, oxygen being readily removed from sulphur dioxide, phosphoric anhydride, boron trioxide, silica, and the oxides of carbon.—On the decomposition by aluminium chloride, of a straight-chain saturated hydrocarbon, by MM. C. Friedel and A. Gorgeu. The reactions have been studied arising between aluminium chloride and the normal paraffins from methane to hexane. The latter, when heated to its boiling point with dry $AlCl_3$ gave rise to pentane and butane, the pentane predominating.—On a peculiar mode of formation of the pollen in *Magnolia*, by M. L. Guignard. As regards the mode of formation of the partitions in the pollen mother-cell, the *Magnolia* present a condition quite unknown in other plants. They are intermediate between Monocotyledons and Dicotyledons, resembling rather the former than the latter.—Extension of No. 162 of the "Disquisitiones Arithmeticae" of Gauss, by M. de Jonquières.—Remarks by M. Hatt on the new portion of the hydrographic map of the coasts of Corsica.—Observations of the new Brooks' comet (October 20, 1898), made at the Observatory of Paris, by M. G. Bigourdan.—On the intermediate integrals of equations of the second order, by

M. E. Goursat.—On singular points situated on the circle of convergence, and on the summation of divergent series, by M. Leau.—Measurement of the velocity of sound, by M. Frot. The experiments were made near Bourges, at a temperature near 0° C., the time being measured automatically by electric chronographs. Two sets of experiments gave for the velocity in air at 0° mean results of 330·6 and 330·9 metres per second.—On the tones of vibrating strings, by M. A. Guillemin. By suitably fixing any portion of a vibrating string any desired overtone can be produced; but this does not in any way prove that this note really existed as a partial tone in the original note given by the string. — On the atomic weight of tellurium, in relation to the multiple proportions of the atomic weights of other simple bodies, by M. H. Wilde.—On the positions of tellurium and iodine in periodic systems of the elements, by M. H. Wilde. Remarks on the recent determination by Metzner of the atomic weight of tellurium (128) as invalidating the periodic arrangements of Mendelejeff, Crookes and others.—On calcium amalgam, by M. J. Ferée.—Action of metallic sulphates on potassium paratungstate, by M. L. A. Hallopeau.—On the amines and amido-derivatives of the aldehydes, by M. Marcel Delépine. A thermochemical paper.—On the changes in composition which take place in fatty seeds in the course of germination, by M. L. Maquenne. The oily materials in the seeds of the earth-nut and castor-oil plant undergo a rapid diminution during germination, the latter being especially marked in this respect, the change being accompanied by an increase in carbohydrates.—Contribution to the biology of wine yeasts, by M. J. A. Cordier. The appearance of *Saccharomyces* upon fruit, especially the grape, at the period of ripening, has hitherto been described as due to the action of insects, but it would appear from the experiments quoted that the air is really the principal factor in the transport of these yeasts.—The specific characters of *Endomyces albicans*, by M. Paul Vuillemin.—On the place of the Phoronidiae in the classification of animals, and on their relations with the vertebrates, by M. Louis Roule.—On the respiratory apparatus of the larvae of entomophagous Hymenoptera, by M. L. G. Seurat. It is shown that the respiratory apparatus of the different larvae of entomophagous Hymenoptera, although all built on the same fundamental plan, present differences in the number and arrangement of some of their parts, sufficient to establish distinctive characters of the several families. There is not yet sufficient knowledge, however, to draw any general conclusions.—On an organ, not previously described, which closes the poison reservoir in ants, and on the method of stinging in the same, by M. Charles Janet.—New observations on the cave and subterranean river of Han-sur-Lesse (Belgium), by M. Martet. The paper is accompanied by a plan and section of the cave and stream. The unknown part of its course is now only two kilometres.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 3.

CHEMICAL SOCIETY, at 8.—A Determination of the Equivalent of Cyanogen: George Dean.—Note on the Action of Light on Platinum, Gold, and Silver Chlorides: E. Sonstadt.—Methanetrisulphonic Acid; E. H. Bagnall.—A Composite Sodium Chlorate Crystal in which the Twin Law is not followed: W. J. Pope.—On the Composition of American Petroleum: Dr. Sydney Young, F.R.S.—(1) On the Separation of Normal and Iso-heptane from American Petroleum; (2) On the Action of Fuming Nitric Acid on the Paraffins and other Hydrocarbons: Dr. F. E. Francis and Dr. Sydney Young, F.R.S.—On the Boiling Points and Specific Gravities of Mixtures of Benzene and Normal Hexane: D. H. Jackson and Dr. Sydney Young, F.R.S.

LINNEAN SOCIETY, at 8.30.—On *Craterostigma pumilum*, Hochst.: Prof. H. Marshall Ward, F.R.S., and Miss Dale.—Amphipoda from the Copenhagen Museum and other Sources, Part II: Rev. T. R. Stebbing, F.R.S.—Exhibitions: Embryos of *Hatteria*: Prof. Howes, F.R.S.—Photographs of Chicken with Foster-Parent a Common Buzzard: Alan F. Crossman.—*Nitella hyalina*, Ag., a New British Plant: H. and J. Groves.

FRIDAY, NOVEMBER 4.

GEOLOGISTS' ASSOCIATION, at 8.—Conversazione and Exhibition of Specimens.

QUEKETT MICROSCOPICAL CLUB, at 8.

TUESDAY, NOVEMBER 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Extraction of Nickel from its Ores by the Mond Process: Prof. W. C. Roberts-Austen, C.B., F.R.S.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—The Tribes inhabiting the Mouth of the Wanigela River, New Guinea: R. E. Guise.

WEDNESDAY, NOVEMBER 9.

GEOLOGICAL SOCIETY, at 8.—On the Palæozoic Radiolarian Rocks of New South Wales: Prof. T. W. Edgeworth David and E. F. Pittman.—On the Radiolaria in the Devonian Rocks of New South Wales: Dr. G. J. Hinde, F.R.S.

THURSDAY, NOVEMBER 10.

MATHEMATICAL SOCIETY, at 8.—Some Secondary Needs and Opportunities of English Mathematicians: Presidential Address.—The Structure of certain Linear Groups with Quadratic Invariants. Dr. L. E. Dickson.—Multiform Solutions of certain Differential Equations of Physical Mathematics and their Applications: H. S. Carslaw.—A Discovery in the Theory of Compound Partitions: Major Macmahon, R.A., F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rotatory Converters: Prof Silvanus P. Thompson, F.R.S.

FRIDAY, NOVEMBER 11.

ROYAL ASTRONOMICAL SOCIETY, at 8.

PHYSICAL SOCIETY, at 5.—Discussion on Mr. A. Campbell's Paper on the Magnetic Fluxes in Meters and other Electrical Instruments, to be opened by Prof. W. E. Ayrton, F.R.S.—On the Propagation of Damped Electrical Oscillations along Parallel Wires: Prof. W. B. Morton.—On the Properties of Liquid Mixtures: R. A. Lehfeldt.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Domestic Hygiene: Dr. A. W. Williams (Bell).—A Manual of the Grasses of New South Wales: J. H. Maiden (Sydney, Gullick).—Manual of Bacteriological Technique and Special Bacteriology: T. Bowhill (Edinburgh, Oliver).—The Teacher's Manual of Object Lessons in Domestic Economy: V. T. Murchè, Vol. 2 (Macmillan).—Electricity made Easy: Drs. Houston and Kennelly (Sonnenschein).—Algebra made Easy: Drs. Houston and Kennelly (Sonnenschein).—The Interpretation of Mathematical Formulae: Drs. Houston and Kennelly (Sonnenschein).—A Pocket Dictionary of Electrical Words, Terms, and Phrases: Dr. E. J. Houston (Sonnenschein).—Organic Evolution Cross-Examined: Duke of Argyll (Murray).—The Groundwork of Science: Dr. St. Geo. Mivart (Murray).—The Natural History of Digestion: Dr. A. L. Gillespie (W. Scott).—Graham-Otto's Ausführliches Lehrbuch der Chemie, Erster Band, Dritte Abthg. (Braunschweig, Vieweg).—University College, Nottingham, Calendar 1898–99 (Nottingham, Sands).—An Introduction to Practical Physics: D. Rintoul (Macmillan).—The Egyptian Soudan: its Loss and Recovery: Lieuts. Alford and Sword (Macmillan).—L'Art de Découvrir les Sources et de les Capter (Paris, Baillière).—Marvels of Ant Life: W. F. Kirby (Partridge).

PAMPHLETS.—Lessons in Domestic Science: E. R. Lush, Part 2 (Macmillan).—Ein Ausflug auf den Aetna: A. Belar (Laibach, Kleinmayr).

SERIALS.—Longman's Magazine, November (Longmans).—Good Words, November (Isbister).—Sunday Magazine, November (Isbister).—Journal of the Royal Statistical Society, September (Stanford).—Transactions of the Institution of Engineers and Shipbuilders in Scotland, October (Glasgow).—Record of Technical and Secondary Education, October (Macmillan).—Chambers's Journal, November (Chambers).—Century Magazine, November (Macmillan).—Humanitarian, November (Duckworth).—National Geographic Magazine, October (Washington).—Physical Review, August (Macmillan).—Contemporary Review, November (Isbister).—Journal of the Royal Microscopical Society, October (20 Hanover Square).

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THURSDAY, NOVEMBER 10, 1898.

AN IRISH ALGEBRA.

The New Explicit Algebra in Theory and Practice: for Teachers and Intermediate and University Students. By James J. O'Dea, M.A., formerly Professor of Mathematics, Natural Philosophy, and English Literature in St. Francis' College, Brooklyn, New York, and St. Jarlath's College, Tuam. Parts I. and II. Pp. x + 616, liv. (Longmans, Green, and Co., 1897, 1898.)

WHATEVER may be thought of the body of this work, there can be no doubt that the preface, at any rate, is remarkably explicit.

"The 'Explicit Algebra' is the result of the Author's earnest desire to facilitate, as much as possible, the labour of masters and students in this department of Mathematics, and to enable them to obtain the maximum results at the minimum expenditure of time and trouble."

Again,

"The Author has spared neither time, nor labour, nor expense in his effort to make the work every way worthy of the object for which it has been intended: namely, as a theoretical and practical text-book on Algebra for all grades of Intermediate Education, University Matriculation (Pass and Honours), and First, Second, and Third Class Teachers."

Finally, having doubtless observed that a certain proportion of reviewers derive the substance of their remarks from authors' prefaces, Mr. O'Dea thoughtfully provides us with a well-balanced appreciation of his treatise ready to our hand.

"The leading features of the 'Explicit Algebra' are fulness of detail, without being uselessly exhaustive; lucidity and conciseness of statement; brevity and neatness in the manipulation of examples, which are numerous and varied, together with copiousness and variety of exercises methodically arranged, while the disposition of the various portions of the work considered as a whole is in strict logical sequence."

In order that the reader may estimate for himself the justification of this modest prologue, we hasten to give a few illustrations.

Page 1, Definitions 3, 4, 5:

"The Symbols of Quantity are the letters a, b, c, d, v, w, x, y, z. These symbols are used to represent numbers."

"An Algebraic Quantity is one that is expressed in algebraic language, and is supposed to be known or unknown."

"A Known Quantity is that which contains a given number of units of the same kind, and is represented by the leading letters a, b, c, d."

Here is fulness of detail, without being needlessly exhaustive!

Page 12 (the last of three pages devoted to addition):

"N.B.—When dissimilar terms which are to be added have a common literal factor, which is called the Unit of Addition, this factor may be annexed to the algebraic sum of the others.

"Example 5. Determine the algebraic sum of

$2a - \sqrt{b} + c$, $3c - 4\sqrt{a} + b$, $3a + d - 2\sqrt{c}$, $m + n - 3\sqrt{a}$.

"Arrange thus:

$$\begin{array}{r}
2a - \sqrt{b} + c \\
-4\sqrt{a} + b + 3c \\
3a + d - 2\sqrt{c} \\
-3\sqrt{a} + m + n \\
\hline
(5\sqrt{a} - 7)\sqrt{a} + (\sqrt{b} - 1)\sqrt{b} + (2\sqrt{c} - 1)2\sqrt{c} + d + m + n."
\end{array}$$

Considering that "literal" and "factor" have not been explained, that nothing has been said about surds except a scrappy definition of the "Sign of Evolution" only intelligible to those who know what a root is, and that the student has actually been left to himself to find out that $2a$ is the product of 2 and a, this is a good sample of Mr. O'Dea's ideas of logical sequence. As another illustration, take the fact that the pupil has no opportunity of practising the use of symbolical language intelligently until he reaches problems on simple equations, p. 165.

The proportion of theory to practice (and such practice!) in this remarkable book is perhaps one to twenty, on a generous estimate. Here are tastes of the author's quality, when he digresses for a time into the barren wilds of theory.

"When an algebraic expression containing x is divided by $x - a$, the remainder is the same as that which results from substituting a for x in the original expression.

"Proof: Let the expression $ax^3 + bx^2 + cx + d$ be divided by $x - a$ until the remainder R, does not contain x, and let the quotient be represented by Q. We then have

$$\frac{ax^3 + bx^2 + cx + d}{x - a} = Q + R;$$

$$\text{"}\therefore ax^3 + bx^2 + cx + d = Q(x - a) + R.$$

"This relation holds for *all* values of x. Hence, since R does not contain x, it will undergo no change whatever value be assigned to x. Substituting a for x, therefore, we get

$$\begin{aligned} a^4 + a^2b + ac + d &= Q(a - a) + R \\ &= Q \times 0 + R = R. \end{aligned}$$

Thus,

$$R = a^4 + a^2b + ac + d.$$

This principle is called the Residual Theorem."

Observe here the charming vagueness of an "algebraic expression"; the ingenious substitution of R for $R/(x - a)$, which is not a misprint, because the same thing is done three times on a previous page; and lastly the use of the same symbol Q to represent two entirely different things, namely the original quotient, and its value when a is put for x.

Here is the "demonstration" of one case of the rule of signs in multiplication:—

$$\begin{aligned} \text{"} -a \times -b &= -a \times m \text{ (assuming } m = -b) \\ &= a \times -1 \times m = a \times -m \\ &= a \times -(-b) = a \times b = ab; \\ \therefore -a \times -b &= +ab.\text{"} \end{aligned}$$

The *petitio principii* in the second line would be hard to beat.

As might be expected, Mr. O'Dea's discussion of the theory of indices affords a magnificent display of his peculiar gifts of "conciseness, lucidity, logical sequence," and the rest of it. To give one instance, on p. 37 we have

$$\begin{aligned} \text{"}\frac{a^m}{a^n} &= \frac{a \times a \times a \ldots (a \text{ being taken } m \text{ times})}{a \times a \times a \ldots (a \text{ being taken } n \text{ times})} \\ &= a \times a \times a \ldots (a \text{ being taken } m - n \text{ times}) \\ &= a^{m-n}:\text{"} \end{aligned}$$

and this is immediately followed by

"Proposition IV.—The reciprocal of any quantity with a positive exponent is equal to the same quantity with an equal exponent taken negatively.

"Proof:

$$\frac{1}{x} = \frac{x}{x^2} = x^{1-2} = x^{-1}.$$

"So, too,

$$\frac{1}{x^3} = \frac{x^2}{x^5} = x^{2-5} = x^{-3},$$

and

$$\frac{1}{x^m} = \frac{x^n}{x^{m+n}} = x^{n-m-n} = x^{-m}.$$

"This is a very useful principle, and should be carefully attended to." This "proof" is repeated later on (p. 253), and the rest of the chapter on indices, so far as theory goes, is of a similar kind.

To give anything like a full account of the contents of this book, its utter absence of plan or proportion, its preposterous and antiquated arrangement, its shallow pretence of "theory," and its innumerable misleading and even erroneous statements, would take up too much space. It does not much matter where we look. "If one root of a quadratic equation be imaginary, the other will also be imaginary," nothing being said as to the reality of the coefficients; "now the greater the value of n, the smaller does r^n become. Hence (!), when n becomes indefinitely great, r^n will become indefinitely small." "Sum (1) to n terms, and (2) to infinity the series $1 + 3x + 5x^2 + 7x^3 + \ldots$," where neither in the question, nor in the solution, is any restriction imposed on the value of x. "Let x = circumference of fore-wheel," &c., concluding with "$x = \frac{504 - 156}{29} = 12$ feet." "Find the values of x, y and z from the simultaneous equations

$$x = a(y + z);\ y = b(z + x);\ z = c(x + y),$$

and prove that $ab + ac + bc + 2abc = 1$"; "the only four factors of 30 are 1, 2, 3, and 5,"—so much for its accuracy in detail. The primary definitions and the four fundamental rules are disposed of in fifty pages, "imaginary quantities" in ten, two of which are taken up by playing tricks with the complex cube roots of unity, while half a page goes to a misleading "demonstration" that $\sqrt{-a} \times \sqrt{-b} = -\sqrt{ab}$; fifty pages are occupied by chapters on indices, surds, and simple equations involving radicals, very inaccurate and choked by the usual fantastic examples; seventy pages are assigned to ratio, proportion, variation, and progressions: such is Mr. O'Dea's conception of the relative importance of the different items of his programme. "Elementary Factoring" (all jumbled up) will be found on pp. 57–73; quadratic equations are deferred until p. 319: logical sequence, forsooth, requires the precedence of Fractions, Involution, Evolution, Indices and Surds, and the substance is sacrificed to the shadow accordingly. Of graphical methods or illustrations there is not a trace: there is not a single geometrical figure in the book; the bearing of algebraical sign upon the "sense" of geometrical and physical quantities is absolutely ignored; and nothing is said about the nature or properties of logarithms. Not only is it possible for a clever boy to work through the whole of this book, and be as ignorant of the theory of algebra as when he began; he will be totally unacquainted with those elementary practical things which are most important for him if he wishes to apply his knowledge to engineering or to physics.

The book is avowedly written to help teachers to obtain "results": that is, to exploit their unhappy pupils for the purpose of scoring in examinations, and so getting grants, or scholarships or some other kind of profit. A method is recommended because it will impress an examiner more favourably, and earn a greater number of marks: the student's attention is directed to this or that, not because it is important in itself, but because the candidate is very likely to be asked a question about it; and an enormous amount of misplaced ingenuity is wasted upon the solution of ridiculous and fantastic questions which ought never to have been set.

It would not be fair to lay the whole blame for all this upon Mr. O'Dea. Like the poor Irish schoolboys, he is the victim of a most iniquitous system: that "payment by results" which warps and corrodes every branch of primary and intermediate education in Ireland. That this plan was originally adopted with the best intentions may be admitted; but it is a disgraceful scandal that it should be continued in Ireland, when it has been (reluctantly enough, it is true) abandoned in Great Britain. The evils of it have been exposed again and again; it has been denounced unanimously by all true teachers who have seen how it works; it puts a premium upon wrong methods, it encourages quackery and cruelty, it destroys sympathy between master and pupils, and the "results" which it produces are a delusion and a sham. It is heart-breaking to think of whole generations of clever, docile Irish lads condemned to the soul-destroying slavery which this rotten system perpetuates. And the evil is intensified when, as in the case of mathematics, the examinations for which the pupils are prepared are thoroughly unsatisfactory. Among the examples contained in this book are the following:—

(1) Simplify

$$\frac{b^2c^2}{(a-b)(a-c)} + \frac{c^2a^2}{(b-c)(b-a)} + \frac{a^2b^2}{(c-a)(c-b)}$$

(Preparatory Grade.)

(2) If $a = 9$, $b = 5$, $c = 2$, $d = 8$, find the value of

$$\frac{c}{\sqrt{a}} + \frac{1}{15}\left(\frac{b}{2}\right)^3 - \frac{3}{40}c^2 - 2\tfrac{1}{3}\sqrt[3]{\frac{1}{d^2} - \frac{ad}{bc^5}}$$

(Preparatory Grade.)

(3) Determine the value of

$$\{x^2 + (a+b)x + ab\}(x^3 + ax^2 + abx + a^2b) - (a^2 + x^2)(x - b)$$

when $x = -a$. (Junior Grade.)

(4) If $a + b + c = 0$, find the value of

$$\frac{b+c}{bc}(b^2 + c^2 - a^2) + \frac{c+a}{ca}(c^2 + a^2 - b^2) + \frac{a+b}{ab}(a^2 + b^2 - c^2)$$

(First Class Teachers.)

(5) If

$$x = \tfrac{1}{2}\left\{\left(\frac{a}{b}\right)^{\frac{1}{2}} - \left(\frac{b}{a}\right)^{\frac{1}{2}}\right\}$$

show that

$$\frac{2a(1 + x^2)^{\frac{1}{2}}}{x + (1 + x^2)^{\frac{1}{2}}} = a + b$$

(Middle Grade.)

(6) Show that the expression

$$\frac{(x+2)^{\frac{1}{2}}}{(x-2)^{\frac{1}{2}}}\left\{\frac{4}{(x^2 - 1)(x^2 - 4)^{\frac{1}{2}} + (x^2 - 3)x + 2} - 1\right\}$$

is equivalent to the fraction $\frac{1 + x}{1 - x}$ (Senior Grade.)

Of these (1) is far too hard for any preparatory grade; (2) is a fine derangement of symbols, wholly unlike anything that occurs in practice (properly so called); (3) is a miserable trap, presumably set for the purpose of inducing the candidates to waste half an hour in working out the products; in (4), if you guess that "the" value is 0, and are handy with your dodges, you will score heavily, otherwise ——!; (5) and (6) speak for themselves. Other examples, equally absurd, may be found by the dozen in the "Explicit Algebra"; in fact, if Mr. O'Dea has made a fair selection, it may be inferred that the Irish Government papers in algebra are occasionally very far from being suitable for the purposes for which they are supposed to be designed. How can teachers, working for a grant, be expected to teach algebra rationally, when the test that is applied to their pupils consists of a silly medley of questions, some threadbare and stereotyped, and others merely puzzling and artificial; while, with the exception, perhaps, of a couple of problems to be solved by equations, no attempt is made to gauge the candidate's reasoning powers?

Meanwhile My Lords the Commissioners of National Education in Ireland refuse to budge, in spite of the overwhelming verdict of competent opinion, nay in defiance of the unanimous protest of their own inspectors (see the *Manchester Guardian* for September 19, p. 7). No doubt their precious system works smoothly enough from their point of view; the papers are set on traditional lines, the marks obtained are neatly tabulated, and the grants and scholarships impartially distributed accordingly; how can any one, they may ask, reasonably object to such an obviously fair and practical procedure? And so the costly, wasteful, and inefficient machinery continues to grind; for all the world like a mill devised to scatter the flour and preserve the husk and bran.

G. B. M.

CLASSIFICATION OF THE VERTEBRATA.

Syllabus of Lectures on the Vertebrata. By Prof. E. D. Cope. Pp. xxxvi + 136. (Philadelphia: University of Pennsylvania, 1898.)

A Classification of Vertebrata, Recent and Extinct. By Dr. H. Gadow. Pp. xvii + 82. (London: Adam and Charles Black, 1898.)

An almost pathetic interest attaches to the former of these works, since it is the last scientific communication which Prof. Cope was able to make to the world, and was sent to press only a few days before his death. Its passage through the press was supervised by Prof. Osborn, who has added, by way of an introduction, an account of the life and works of the late Professor. The "Syllabus of Lectures," as it now appears, is a classification of the Vertebrata slightly expanded, and constitutes an elaboration of the scheme which Prof. Cope propounded some years ago in the *American Naturalist*.

The fertility which Prof. Cope has always exhibited for inventing new names is here seen to perfection, though it will probably be regarded with some consternation by the rising generation of students. Tables are given showing the stratigraphical range of the chief divisions, and the illustrations, though many of them crude, are a useful addition.

Ichthyologists who are conversant with Prof. Cope's works will not be surprised to find the Ostracoderms grouped with the Cyclostomes, but the definite inclusion of the Tinamous with the Ratite birds will find little support among ornithologists. Many of the expressions used are ambiguous, and even misleading. The urostyle of the Anura, being situated behind the sacral vertebra, cannot be formed of united *lumbosacral* vertebrae (p. 43), and the statements concerning the absence of median fins in Batrachia (p. 12), and the freedom of the palato-pterygoid arch in the Dipnoi (p. 17), require explanation.

The editing of the work, moreover, is not above criticism, *Serpentes* and *Ophidia* occurring indifferently, and on the same page, as the ordinal name of the snakes (p. 75). The oldest multituberculate mammals are said to occur in the "Trias of South Africa in the Karoo Beds," (p. 103)—evidently a tacit reference to *Tritilodon*—and yet Tritilodon is classed with the Gomphodont reptiles on page 65.

Dr. Gadow's book is more likely to find favour with European students, the names given to the groups being more familiar. The convenience of the reader is studied by leaving the left-hand pages blank for annotations. The geological range of the extinct forms, and the geographical distribution of the recent ones are given; and the glossary, showing the derivation of most of the Latin and Greek names, is both useful and accurate.

Dr. Gadow appears to be chary of accepting taxonomic innovations, yet loath to ignore them, and the result is not unfrequently incongruous. He does not support Cope so far as to place the Ostracoderms with the Cyclostomes, but creates for them a new and unnecessary super-class, the "Hypostomata" (p. 4), equal in value to, and intermediate between, the Cyclostomes and the Gnathostomes. And again, while not bold enough to follow Hubrecht in including *Tarsius* with the apes, he yet goes so far as to give it a sub-order all to itself (p. 53).

The diagnoses are not always full enough to be effective (that of the Prosauria, p. 17, not excluding the Geckoes); and even the most elementary student of zoology will object to the statement (p. 43) that the tibia and fibula are separate in the rabbit.

The book, however, in spite of some blemishes, will prove a useful addition to the student's library.

OUR BOOK SHELF.

First Principles of Electricity and Magnetism. By C. H. W. Biggs. Pp. 481 + xv. (London: Biggs and Co.)

This book is intended, it is stated in the author's preface, for beginners in practical work, and is an expansion of a series of papers which appeared in the *Electrical Engineer*. The author considers it necessary to lead off with a chapter on atoms, molecules, mass, force, weight (and the fundamental units), work and energy. The idea evidently is to convey to the beginner information in a more or less familiar and chatty style, and the book is certainly readable. We wish we could say that the information was always quite correct. As containing examples of well-meant but inaccurate statements, we may refer to the explanation (?) of the different gravit-

ational attractions in the same mass at different points of the earth's surface. The account of the effect of the flattening at the poles leaves much to be desired, and the effect of centrifugal force is not even mentioned.

Again, on p. 21 we have "unit acceleration as in scientific calculations, usually 1 centimetre per second. In many practical calculations it is 1 foot per second." Whatever may figure in practical calculations, it is certain that neither of these is scientifically an acceleration at all. Also, though we have no wish to be hypercritical, there is something quaint about the equation

"$150 \times 25 = 3750$ poundals."

When Mr. Biggs comes to electrical matters he is happier. His descriptions of hydrostatic analogies may help some readers, *e.g.* the inquiring town councillor, to form an idea of "electrical pressure," though we fear the notion may linger that it is really a kind of pressure.

But when he gets to Ohm's Law, Mr. Biggs says, after arriving at the result $C \propto E/R$, "In the early part of this century, Prof. Ohm proved more than this with steady continuous currents, not only that $C \propto E/R$, but that $C = E/R$, or expressed numerically in practical units, amperes $= \frac{\text{volts}}{\text{ohms}}$." How Prof. Ohm "proved" this Mr. Biggs has not divulged, and it would be interesting to know. We had thought, innocently, that the *equality* of C to E/R was an affair of choice of units, and not of proof at all.

The cuts in the book are numerous, but, except a few here and there, are badly printed. The figure, on p. 185, of a long thin gentleman (in a rather modern dress) extended along a rod inside what looks like a stone coffin several sizes too big for him, at first sight startled us. Underneath, in black type, was the legend, "A Stretch of the Imagination"! but this, we found, referred to the following paragraph, which, curiously enough, deals with elastic threads.

The latter and really practical part of Mr. Biggs' book may be of service to some readers. It contains a good deal of useful information, conveyed in Mr. Biggs' genial, if a little conscious, style. But we should counsel a really earnest student, and especially a beginner, to choose a text-book in which a more serious attempt is made to grapple with the real difficulties of the subject.

Medical Diseases of Infancy and Childhood. By Dawson Williams, M.D., F.R.C.P. (Lond.), Physician to the East London Hospital for Children, Shadwell. Pp. xiv + 634. Plates 18; figures 18. (London: Cassell and Co., Ltd., 1898.)

THE book before us, which is correctly described by the author as a handbook, is intended "to act as a guide to clinical study" to young practitioners of medicine, and those who have not previously paid much attention to the subject. After introductory chapters treating of growth, clinical examination and food, the author proceeds to consider the individual diseases of children, and to indicate how the pathological processes, and their accompanying clinical phenomena, are different in children and adults. It would, of course, be impossible in a short notice like the present to give an account of the varied and practical information contained in Dr. Williams's book. Under the heading of diphtheria, the results of the antitoxin treatment, as culled from the statistics of the Metropolitan Asylums Board and the American Pediatric Society, are given, the author rightly observing that the statistical figures are actually less favourable than the reality. The interesting subject of the effect of the antitoxin treatment upon the complications of diphtheria, so often of such importance in children, is also discussed. Cretinism and its treatment by administration of the thyroid gland is considered. Hepatic disease in children, often a subject of considerable difficulty to the practitioner, is well treated. A list of prescriptions, a few invalid cooking receipts, and a good index conclude the volume. The book will unquestionably be of use to the general practitioner and the student, and, while not capable of replacing the larger text-books on the diseases of children, will form a most valuable supplement to the various treatises on general medicine. F. W. T.

A Text-book of General Botany. By Carlton C. Curtis, A.M., Ph.D., Tutor in Botany in Columbia University. Pp. viii + 359. (New York, London, and Bombay: Longmans, Green, and Co., 1897.)

DR. CURTIS has added another to the existing long list of intermediate botanical text-books. His book is readable, and on the whole a fairly good one, and the number of new illustrations it contains at once impress the reader in its favour. Opening with a general account of anatomy, he devotes the second chapter to physiology. But the great bulk of the book (p. 87–340) is given up to systematic and morphological matters. A very short sketch of palæobotany, together with an index, conclude the work. The general treatment is based on the type system, and Dr. Curtis has done well in showing how this much abused method lends itself in reality very well to a connected exposition of the taxonomic parts of botany. Unfortunately, perhaps inevitably, the text is rather scrappy in many places, although this is partly atoned for by the fulness of the many laboratory exercises which are distributed through the book.

We have noticed a rather considerable number of misprints scattered through the pages; these will doubtless disappear in a future edition, which is almost sure to be called for, since the book, if used as an adjunct to the laboratory in the sense intended by its author, supplies a distinctly felt need for a guide suitable for intermediate students.

Domestic Hygiene. By Arnold W. Williams, M.B. C.M. (Edin.), D.P.H. (Lond.). Pp. 175. (London: George Bell and Sons, 1898.)

The Teacher's Manual of Object Lessons in Domestic Economy. Vol. ii. By Vincent T. Murché. Pp. viii + 334. (London: Macmillan and Co., Ltd., 1898.)

Lessons in Domestic Science. Part ii. By Ethel R. Lush. Pp. 77. (London: Macmillan and Co., Ltd., 1898.)

THESE three volumes all deal worthily with matters included in the science of health, and they will all assist in extending a knowledge of the laws of life. Dr. Williams's manual contains the substance of lectures delivered by the author at many rural and urban districts on the causes and prevention of disease and co-related subjects affecting the public health. The book will be found of service to technical instruction classes and others of a similar kind.

Mr. Murché's book is "adapted to meet the requirements of the Education Department in the Class Subject of Domestic Economy as laid down in the Code for 1898." It contains notes and hints for teachers who have to teach domestic economy to Standards III. and IV. of public elementary schools. In the former standard, the children are expected to know something of the materials used in clothing and the materials used in washing; in the latter standard, they are taught simple facts concerning the use and sources of food, the hygiene of clothes, and laundry-work. Mr. Murché's books have all been received by favour with teachers engaged in elementary schools, and the present volume will doubtless have the same welcome extended to it.

Domestic science is a new subject recently adopted by the Education Department. It differs from domestic economy in the fact that principles rather than processes are dealt with. The parts of the subject included in Miss Lush's booklet refer to the functions and preparation of food, and the dwelling. A course such as it provides educates as well as interests the pupils.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Origin of the Aurora Spectrum.

IN your issue of June 16, Prof. Schuster calls attention to the fact that the wave-length of the aurora line nearly coincides with the wave-length of the bright green line in the spectrum of krypton. Prof. Ramsay and Dr. Travers give the wave-length of this line as 5566·3. I find it to be 5570·40 (Rowland's scale), which brings the line close to the mean of the best determinations of the aurora line. According to Scheiner ("Die Spectralanalyse der Gestirne") the best measures, when reduced to Rowland's scale, are :—

Angström ...	5568	Huggins ..	5572
Vogel	5572	Copeland ...	5573
Vijkander ...	5573	Gyllenskiöld	5569
Lemström ...	5570		

Mean 5571·0.

To this must be added Campbell's determination at Mount Hamilton: 5571·6 (see translation of Scheiner's "Sp. d. Gest." by E. Frost, p. 326).

Considering the difficulty of measuring the aurora line, I think the difference is not too large to be compatible with the identity of the lines. Satisfactory evidence might be gained, if the other krypton lines could be observed in the spectrum of the aurora. I subjoin the mean of four different determinations of the yellow and green krypton lines. They were photographed on orthochromatic plates, together with lines of mercury, sodium and argon, which served as standards.

	Mean error.	Ramsay and Travers.
5562·35	0·03	5557·3
5570·40	0·03	5566·3
5871·10	0·03	5866·65

Hannover, Technische Hochschule, November 2. C. RUNGE.

The Boring at Funafuti.

FURTHER information has been received this week from Prof. David, of Sydney, as to the progress of the boring at Funafuti. On September 6 it had reached a depth of 987 feet, passing through a hard dolomite-like coral rock, apparently similar to that mentioned previously as occurring below about 700 feet. Boring in the bed of the lagoon from the deck of H.M.S. *Porpoise* had been continued; the one mentioned in your last number was carried through sand, composed of fragments of calcareous organisms in which broken pieces of coral became commoner in descending, to a depth of 144 feet in the bed-rock of the lagoon, or in all 245 feet below sea-level. There progress was stopped by hard coral rock, which could not be pierced, because the great length of unsupported pipe (about 120 feet) made driving impossible, and the loose stuff above prevented them from applying another device. Captain Sturdee, though unable to stay much longer at the island, contrived to move the *Porpoise* about 90 feet nearer to the centre of the lagoon, where another boring was made at about the same depth. This was carried through 80 feet of sand, as before, which was then succeeded by a rather hard coral gravel; the lumps varying up to the size of a man's fist. It was pierced to a depth of 33 feet, when the time limit was reached, and the work was necessarily abandoned. The results, however, are most interesting, and our friends in Sydney may be congratulated on the success of boring so far in a depth of a hundred feet of water. When letters left the island the main bore was still progressing, though the supply of diamonds was nearly exhausted, so that there seems every hope that it will be carried below a thousand feet. But what has been already accomplished will be an immense addition to our knowledge of atolls.

T. G. BONNEY,
Vice-Chairman of the Coral Reef Committee of the Royal Society.

Asymmetry and Vitalism.

It seems to me that Prof. Japp has not understood the purpose of my reference to "the formation of hematite nodules and flints in chalk." I instanced this simply as showing that segregation slowly takes place notwithstanding great restraints, such as that which a chalk-stratum offers; and my argument was that if segregations of hematite and flint take place in long periods notwithstanding such great restraints, it may reasonably be inferred that segregations of such slightly-different molecules as those of dextro- and laevo-protein would gradually take place under the slight restraints offered by a colloidal substance like protein. Unless due time is given, nothing can be expected.

Prof. Japp thinks I do not "quite realise to what extent enantiomorphous molecules are alike." He says that the two classes of molecules differ only as right and left hands differ. That seems to me a sufficient difference to determine segregation. There must be different *attitudes* in relation to incident forces. Can it be held that differences of attitude have no effects? The members of a mixed mass of molecules differing in their attitudes could not react in absolutely the same manner upon incident forces; and it may be inferred that their differential reactions will produce differential motions.

But Prof. Japp's fundamental fact seems to me to furnish an answer to his criticism. The basis of his argument is that these groups of right-handed and left-handed molecules severally produce rotation of a polarised ray in different directions. If they thus act differently upon the ray when they form an aggregate, they must act differently upon it when existing individually. Though in a mixed aggregate their respective actions on the ray cancel one another, yet each molecule of either kind will be acted upon and will react differently from each molecule of the other kind, and their reactions will *not* cancel one another. Hence there will be initiated those differences in their behaviour which cause segregation. If in a state of nature they are under some conditions subject to polarised rays, the implication seems to be that this result will take place. HERBERT SPENCER.

Brighton, October 29.

I DO not understand how Mr. Herbert Spencer can imagine that the action of plane-polarised light (a form of energy which is merely polar—not asymmetric) can possibly effect the separation of enantimorphs. As I pointed out in my former letter, nothing short of an asymmetric influence could do this.

Speaking of enantiomorphous molecules, Mr. Spencer says: "There must be different *attitudes* in relation to incident forces. Can it be held that differences of attitude have no effects?"

There will undoubtedly be differences in the effects; but, owing to a peculiarity in the behaviour of enantiomorphs under the influence of symmetric forces, these differences will not be apparent in the final result. Thus, if we subject dextro-tartaric acid and laevo-tartaric acid separately to the action of heat, both will decompose at the same temperature and at the same rate, and will yield the same products in the same relative amounts. There is a "difference of attitude," and there will be a difference in the "effects," so far as in the one case some of the right-handed acid becomes left-handed, whilst in the other, some of the left-handed acid becomes right-handed; and in both cases, by similar inverse changes, stopping short, however, half-way, some mesotartaric acid is formed. But in both cases the final result is the same: namely, the establishing of an equilibrium represented by an optically inactive mixture of racemic acid with a little mesotartaric acid. There is a difference in the two *changes*—a difference which our knowledge of the opposite asymmetry of the two initial compounds enables us to read into the processes, thus saving Mr. Spencer's general proposition; but there is no difference in the *results*. But it is quite evident, from what Mr. Spencer has written about the separation of enantiomorphs, that it is in the results that he expects to find a difference; and here he will be disappointed, so long as symmetric influences only are brought to bear on enantiomorphs. Under such influences, just as in the foregoing case, *there occur two changes of inverse character, conditioned by, and exactly balancing, the inverse character of the two enantiomorphs, so that the final result is the same for both enantiomorphs.* This is what Mr. Spencer overlooks. He does not perceive that a uniform force acting upon two enantiomorphs may be modified by them so as to act in two opposite asymmetric modes. He must interpret his third "abstract proposition" and its corollary

(NATURE, vol. lviii. p. 592, col. 2) so as to include these special cases.

Similar considerations would apply to the action of polarised light on a mixture of enantiomorphs. The most that could occur would be the production of an equal rotation of enantiomorphous molecules in opposite senses, corresponding with their opposite asymmetry. That would not cause separation.

Again, take Mr. Spencer's first "abstract proposition" (*loc. cit.*), which runs: "Like units subject to a uniform force capable of producing motion in them, will be moved to like degrees in the same direction." How does he reconcile this statement with the fact that enantiomorphs have the same heat of formation: *i.e.* that the same atoms are moved by the same amounts of energy, not in the same direction, but in directions of opposite asymmetry, so as to form two asymmetrically distinct compounds?

I probably do Mr. Spencer no injustice if I assume that in 1862, when he formulated these "abstract propositions," he was not acquainted with the theory of molecular asymmetry, which at that time was not generally current, even among professed chemists. And if I might do so without offence, I would suggest that he should read the portion of Van 't Hoff's "Arrangement of Atoms in Space" (second edition) dealing with the question of molecular asymmetry, especially the section which describes the character of the isomerism due to the asymmetric carbon atom. He may then be able to recast his "abstract propositions" so as to include, at least more explicitly, the formation and behaviour of enantiomorphous molecules under symmetric influences F. R. JAPP.

The University, Aberdeen, November 2.

I AM not sure that much is to be gained by continuing this discussion further, but perhaps I may be permitted to add something to my first criticism of Prof. Japp's standpoint in view of his communication in last week's NATURE.

The statement of Prof. Japp's, which I specially criticised, was the following (where I italicise the words to which I wish to draw particular attention):—But the *chance* synthesis of the simplest optically active compound from inorganic materials is *absolutely inconceivable.*

To this I replied and still reply, it is *not* absolutely inconceivable. An optically active compound means merely a preponderance of one kind of enantiomorph, and *chance* will always produce this, given enough trials and length of time to make them. Prof. Japp twits me with the ineffectiveness of twenty molecules, but I spoke not of twenty molecules, but of twenty coins, in order to bring home to Prof. Japp what a deviation from the average in the theory of chance really means. The probability of a deviation of 5000 in 1,000,000 molecules is easily calculated, and such a deviation is quite "conceivable," even if it be very infrequent. A deviation of 5000 in 1,000,000 molecules would give an optically active solution, whether sufficiently intense to be observed by the means at our disposal is another question. The statement that on the theory of *chance*, an optically active compound is *absolutely inconceivable* is, I take it, absurd. It may be very *improbable*, but this is not the term used by Prof. Japp.

Prof. Japp writes in his letter: "Prof. Pearson's twenty non-living asymmetrical molecules formed by the chance play of mechanical forces, would, so far as experiment informs us—although I freely admit that mere negative results are not conclusive—have no more influence on the asymmetry of other molecules formed in their neighbourhood than one toss of a coin has upon another toss." I reply that I think experiment shows they *have*. It is possible in Jungfleisch's process to get crystals which are purely right- or left-handed up to the size, say, of half an inch, sufficiently large for picking out. Now I take it that it is chance which produces a slight majority of one type of enantiomorphs at one or other point, and what I have termed "breeding," which encourages the collection of that type at the given centre until we get crystals purely right- or left-handed up to a size of half an inch. That a number of molecules of one kind, such as are required for these crystals, should be frequently formed, is totally opposed to the theory of *chance*, but I take it that a slight chance preponderance sets the "breeding" going.

Take a dish of such crystals and throw them out at random, and they scatter in all directions; one such crystal coming into a few drops of fluid forms an optically active medium consisting of enantiomorphs of one kind only. Thus even a total disappearance of one kind of enantiomorphs is not impossible, or "absolutely inconceivable" on the theory of *chance*. Prof. Japp speaks of the "vague and elastic" way in which I speak of the "breeding" process—I notice that Prof. Errera also uses the phrase "asymmetry begets asymmetry as life begets life." Let us confine the term then, for the present, simply to the process (of which so far the mechanism is unintelligible) by which chance having given a slight local preponderance of one type of enantiomorph, a group of the same type, visible and touchable, is formed there. It is perfectly conceivable that this is only a visible representation of the process by which living asymmetry selects its like, even in a non-crystalline compound. It is only the mechanism which is vague, not the fact.

Prof. Japp really complains in his address that an "eminent physicist" should say that an explanation of rotatory polarisation is still wanting. It is still wanting, because no *kinetic* theory, which is what a physicist requires, can be provided by what is after all only a geometrical *schema* of the chemist. Prof. Japp now writes that every chemist recognises that it is only a geometrical hypothesis, and he did not think so obvious a qualification needed statement to an audience of chemists. Then why, I ask, should Prof. Japp go out of his way to say that the theory was unknown outside the circle of organic chemists, and cite the "eminent physicist" as an example of such ignorance?

The fact is, that the moment we look at Prof. Japp's tetrahedron atoms, Figs. 1 and 2 of his paper, as *dynamical* systems, the right-handed and left-handed molecules do not respond in the same manner to symmetrical forces. The atoms not being identical, the centroid will not necessarily be the centroid of the tetrahedron; say, it is somewhat nearer to Z′ than H. Now whirl a thin cylindrical sheet of optically inactive mixture round the axis of the sheet, left- or right-handed rotation is indifferent; the left-handed tetrahedra will not be in *stable* equilibrium relatively to the centroid of the molecule in the same position as the right-handed. Consequently the former will all set, say, their X′ angle inwards, and the latter outwards; or at least some similar like difference of positions will differentiate like from unlike enantiomorphs. Now let a strip of the cylindrical surface be placed horizontally and allowed to fall, say, through a viscous fluid, the resistance to a tetrahedron going X′ foremost, may well be greater or less than one going HZ′Y′ foremost, and if so the left-handed molecules will be separated ultimately from the right. All this is purely hypothetical, but I introduce it because Prof. Japp asserts that it is "impossible" for any mechanical (symmetrical) forces to constantly select one of two opposite forms. I reply that the impossible is conceivable, if he will treat his molecules not as geometrical *schemas*, but as dynamical systems.

One last word. Prof. Japp refers in his address to a "vital force" which does not disobey the law of energy, but is purely *directive* of motion. I have seen such an idea several times mooted. The question is not, however, if something called vital force obeys the law of the conservation of energy, for the principle of energy *never* fully defined any motion, something else is also directly or tacitly assumed. In itself it only leads to *one* equation, not sufficient to describe any motion. The problem is whether "vital force" obeys *all* the laws of motion—for example the conservation of momentum, angular and linear, which it could hardly do if it changed the direction of motion. I am quite unable to realise why some chemists and physicists seem to think a disregard for the conservation of momentum less miraculous than a disregard for the conservation of energy. I do not see why the less important principle should be made more of a fetish than the wider reaching principle. If "vital force" does obey all the laws of motion, then it can only be a rather bad name for some piece of mechanism, to which the most ardent supporter of a mechanical theory of the universe (such as Buchner or Moleschott, not I) could not possibly object. KARL PEARSON.

University College.

WHILST Prof. Japp is to some extent justified in saying that all his critics "seem to be moving in that unreal world where a fount of type, if jumbled together sufficiently often, ends by setting up the text of *Hamlet*," still it must be borne in mind that he himself provoked a discussion in such an imaginary region by raising the question as to the possibility of producing, without the interference of a living agency, an optically active

substance unaccompanied by its enantiomorph. The possibility of such an occurrence has been pointed out by Profs Karl Pearson and Fitzgerald, and is of course open to no doubt. Indeed, to use Dr. Japp's own simile, it must be conceded that if the type were jumbled an infinite number of times, it would lead not only once but an infinite number of times also to the text of *Hamlet* being set up! In the matter of the synthesis of asymmetric molecules throughout the past history of the earth we are, it is true, not dealing with an infinite number of events, but still with a number of an extremely high order, and in the course of this enormously long series of events such an exceptional occurrence as the exclusive production of a considerable aggregation of similarly asymmetric molecules may have taken place. This Prof. Japp himself appears to recognise, but he does not admit that such an aggregation of asymmetric molecules can by "breeding" add to the number of asymmetric molecules which are unaccompanied by their enantiomorphs, and he has disposed of the vague suggestions of such breeding advanced by his critics. He appears to me, however, to have overlooked one possible way in which such breeding can occur. If we take an asymmetric molecule containing for simplicity a single asymmetric carbon atom, and by purely chemical synthesis generate a second asymmetric carbon atom in the molecule, the new carbon atom may, as we know from the researches of Emil Fischer, always have the same asymmetry, to the exclusion of its enantiomorphous arrangement. But these asymmetric molecules containing two asymmetric carbon atoms might by purely chemical processes be broken down so that each yielded two molecules containing an asymmetric carbon atom apiece. Each of these two resulting molecules with their single asymmetric carbon atom would now be ready to go through a similar cycle of changes which would result in four molecules, each containing a single asymmetric carbon atom, and so on. In this manner an indefinitely large number of asymmetric molecules, unaccompanied by their enantiomorphs, might be bred from a single one without the interference of any asymmetric agency, living or otherwise.

It appears to me also quite possible that the asymmetry of solar radiation may originally have determined the exclusive synthesis of one enantiomorph, and that the latter was in some way or other utilised in the evolution of the first organism, by which then this particular enantiomorphism was further transmitted indefinitely. This is an entirely different idea from that which led Pasteur to try his celebrated but abortive experiments on plants in the hope that by reversing the asymmetry of the sun he would obtain the vegetable asymmetric products of the reverse sign to that which they normally possess. When Pasteur became a biologist as well as a chemist, he rapidly realised that the asymmetric influences present in the germ of life itself far outweigh the asymmetric influence of solar radiation in determining the formation of one enantiomorph to the exclusion of its fellow. It has indeed always appeared to me highly remarkable that Pasteur should have embarked on these particular experiments at all, inasmuch as the negative answer to his inquiry is already given by nature; for, as Prof. Japp points out, the asymmetry of solar radiation in the northern is the reverse of that in the southern hemisphere, whilst the asymmetric vegetable products in both hemispheres are identical and not enantiomorphous. PERCY F. FRANKLAND.

Mason University College, Birmingham, October 31.

The November Meteors.

PROF. J. COUCH ADAMS, in his classical investigation into the dynamics of the great Leonid swarm, employed Gauss's method in determining the perturbations of the surrounding planets upon these meteors. Gauss's method furnishes the average amount of each perturbation, and although this was sufficient for the immediate object which Prof. Adams had in view, it has appeared desirable to penetrate more deeply into the problem.

With this end in view the actual perturbations during the 33¼ years of the present revolution are being computed under the direction of Dr. Downing, F.R.S., the Superintendent of the Nautical Almanac, the calculations being made for meteors occupying a definite position in the stream, viz. that through which the earth passed in 1866. This computation will be completed within the next few days; and as the result, so far as the motion of the node is concerned, can be made the basis of an attempt to forecast the times of the greater showers—one of which may possibly present itself next week—it seems desirable that this use shall be made of the work which is being done.

The greater Leonid showers are occasioned by the earth passing through the stream of ortho-Leonids, *i.e.* those numerous Leonids which revolve round the sun in nearly identical elliptic orbits. There are other Leonids moving in orbits that sensibly differ from the ortho-orbit, and these may be called clino-Leonids. Some of the clino-Leonids encounter the earth in rather scattered formation every year, but the ortho-Leonids are a dense procession of meteors advancing along nearly coincident paths and occupying only a portion of the orbit at any one time.

It is just possible that the front of this procession may extend far enough forward for the earth to encounter it this year, and we are almost certain to pass through the stream in the Novembers of next year and of one or two of the following years. On each such occasion the earth receives a downpour of meteors which lasts for so few hours that those observers only who are fortunate enough to be on the advancing side of the earth can witness the marvellous display.

If there is one of these greater showers this year; if the meteors that shall constitute it traverse the same orbit as did those that the earth encountered in 1866; and if the advance of the node since 1866 were the same as that assigned by Gauss's method: then would the middle of the shower of this year occur at the time

1898 November 14d. 5h.

But the computation which is being made under Dr. Downing's direction shows unmistakably that the last of these conditions has not been fulfilled, that on the contrary the perturbations during this revolution, especially those arising from Jupiter and Saturn, have been far above the average.

Now all the calculations which have been made refer to meteors situated at what we may call Station A in the procession, by which is meant that part of the stream through which the earth passed in 1866. This part of the stream will not return to the node—the point of intersection between the meteoric orbit and the earth's orbit—till the end of January 1900. Accordingly Station B, which the earth will encounter this year, is situated in the procession about a year and a quarter in advance of Station A.

The relative positions of the disturbing planets and the meteors make it almost certain that meteors B have suffered perturbations during the current revolution, which sensibly differ from those affecting meteors A; but the difference is probably not very large. Again, they may have started along slightly different orbits. And, thirdly, Adams's orbit can only be relied on as approximate, since it is based on an insufficient determination of the radiant.

On these accounts there is risk of error in applying to meteors B, the results obtained in the case of meteors A.

With these reservations we may venture to make the correction; and accordingly it is intended as soon as the computer's work is sufficiently advanced, to send to the daily papers (since NATURE will be published too late) an announcement of the amount of the correction found in the case of meteors A. It will probably correspond to an epoch, several hours, possibly more than a whole day, later than that calculated on the average shift of the node.

If when the correction is published it is applied to the date given above, viz. to 1898 November 14d. 5h. (5 o'clock in the afternoon of Monday the 14th instant), it will furnish the best attempt which the data at our disposal seem to permit, to assign the time of the great shower if such an event occurs this year. It will be understood that this can only be offered as a prediction with the important reservations enumerated above.

Everything as yet known seems to betoken that the true time will prove to be many hours later than 5 o'clock on Monday afternoon, so that if one of the great meteoric showers reaches the earth this year it may perhaps happen on Monday night after half-past ten, or on Tuesday night after the same hour, in either of which events it will be visible from all stations on this side of the earth where the sky is not clouded.

G. JOHNSTONE STONEY.

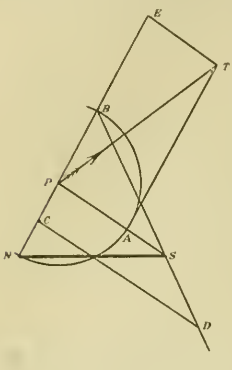
8 Upper Hornsey Rise, N., November 6.

Construction for the Direction of a Magnetic Line of Force.

In Prof. Gray's review of Riecke's *Lehrbuch*, a construction for the direction of the line of force at any point, due to a short magnet, is given.

If the magnet be long, then the following construction holds:

Let N and S be the two ends of the magnet and P the point, nearer, say, to N than to S. Take A in PS and B in NP produced, so that PA = PB = PN. Take C in BN, so that BC measured towards N equals PS. Draw CD parallel to PS, D being in the line BS. Measure PE away from N, so that PE = CD. The diagonal PT of the parallelogram AE is the direction required.



J. H. Vincent.

Cavendish Laboratory, Cambridge.

The determination of the direction of the resultant force, at any point, due to a long, thin magnet, is of some importance as a laboratory exercise, and it is necessary to be able to compare the direction which a small needle takes up in its field with the theoretical direction. For such an exercise the bar should be a long, thin magnet as nearly uniformly magnetised as possible. For this case Mr. Vincent's construction gives the theoretical direction very neatly.

The direction may also be found by dividing the line NS externally, at a point R, say, in the triplicate ratio of NP to SP. The line joining R to P is the direction sought. This construction can be made with only a parallel ruler.

My friend Mr. G. B. Mathews has pointed out to me that this construction may be very conveniently used to draw the whole family of curves. For describe a circle through P dividing NS internally and externally in the ratio of NP to SP. The lines joining any point on this circle with N and S are in this ratio. Hence the direction of the force at each point of the circle is the line joining it with R. Thus, by a succession of circles and corresponding positions of R, the whole series of curves can be laid down.

The following method is perhaps not so good, but is also very easy to remember. A diagram is not necessary. Describe a circle touching the line NP at N, and cutting the line SP produced beyond P in the points H, K, of which H is the nearer to P. From P towards N lay off a distance PL equal to PH, and through L draw a circle touching SP at S and cutting PN, produced, if necessary, in M. The diagonal passing through P of the parallelogram described on PK, PM as adjacent sides is in the direction of the line of force at P.

When either of the angles SNP, NSP is very obtuse, the last construction should be carried out by drawing the circles so as to give equal segments PH, PL both lying on the side of P towards NS. Then a distance PK′ = PK can be laid off along SP produced, and the parallelogram described on PK′, PM as adjacent sides. There are probably a great many ways of solving this problem: I have hit upon three other distinct methods, which I will not take up space with describing here. I may mention also that I have given a simple method of laying down successive points on a line of force in my "Magnetism and Electricity," vol. i. p. 14, figs. 12 and 13.

The construction for the direction of the force due to a short magnet, described in my review of Prof. Riecke's book, was given by Hansteen ("Magnetismus der Erde," s. 208), and again by Gauss ("Vorschriften," &c., Werke Bd. 5, s. 435). It is to be found in Prof. Chrystal's article on "Magnetism" in the "Encyclopaedia Britannica," and in my treatise on "Absolute Measurements," vol. ii.

A. Gray.

THE CHEMISTRY OF THE STARS.[1]

When, on returning from India, I found that you had during my absence done me the honour of unanimously electing me your President, I began to cast about for a subject on which to address you. Curiously enough, shortly afterwards an official inquiry compelled me to make myself acquainted with the early doings of the Royal Commission of the Exhibition of 1851, on which I have lately been elected to serve, and in my reading I found a full account of the establishment of your Institute; of the laying of the foundation-stone by the late Prince Consort in 1855, and of his memorable speech on that occasion. Here, I thought, was my subject; and when I heard that the admirable work done by this and other local institutions had determined the inhabitants of this important city and neighbourhood to crown the edifice by the foundation of a University, I thought the matter settled.

This idea, however, was nipped in the bud by a letter which informed me that the hope had been expressed that I should refer to some branch of astronomical work. I yielded at once, and because I felt that I might thus be able to show cause why the making of knowledge should occupy a large place in your new University, and thus distinguish it from other Universities more or less decadent.

The importance of practical work, the educational value of the seeking after truth by experiment and observation on the part of even young students, are now generally recognised. That battle has been fought and won. But there is a tendency in the official direction of seats of learning to consider what is known to be useful, because it is used, in the first place. The fact that the unknown, that is the unstudied, is the mine from which all scientific knowledge with its million applications has been won is too often forgotten.

Bacon, who was the first to point out the importance of experiment in the physical sciences, and who predicted the applications to which I have referred, warns us that "lucifera experimenta non fructifera quaerenda": and surely we should highly prize those results which enlarge the domain of human thought and help us to understand the mechanism of the wonderful universe in which our lot is cast, as well as those which add to the comfort and the convenience of our lives.

It would be also easy to show by many instances how researches, considered ideally useless at the time they were made, have been the origin of the most tremendous applications. One instance suffices. Faraday's trifling with wires and magnets has already landed us in one of the greatest revolutions which civilisation has witnessed; and where the triumphs of electrical science will stop, no man can say.

This is a case in which the useless has been rapidly sublimed into utility so far as our material wants are concerned.

I propose to bring to your notice another "useless" observation suggesting a line of inquiry which I believe sooner or later is destined profoundly to influence human thought along many lines.

Fraunhofer at the beginning of this century examined sunlight and starlight through a prism. He found that the light received from the sun differed from that of the stars. So useless did his work appear that we had to wait for half a century till any considerable advance was made. It was found at last that the strange "lines" seen and named by Fraunhofer were precious indications of the chemical substances present in worlds immeasurably remote. We had, after half a century's neglect, the foundation of solar and stellar chemistry, an advance in knowledge equalling any other in its importance.

[1] An inaugural address delivered at the Birmingham and Midland Institute on October 25, by Sir Norman Lockyer, K.C.B., F.R.S., President.

In dealing with my subject, I shall first refer to the work which has been done in more recent years with regard to this chemical conditioning of the atmospheres of stars, and afterwards very briefly show how this work carries us into still other new and wider fields of thought.

The first important matter which lies on the surface of such a general inquiry as this is that if we deal with the chemical elements as judged by the lines in their spectra, we know for certain of the existence of oxygen, of nitrogen, of argon, representing one class of gases, in no celestial body whatever; whereas, representing other gases, we have a tremendous demonstration of the existence of all the known lines of hydrogen and helium.

We see then that the celestial sorting out of gases is quite different from the terrestrial one.

Taking the substances classed by the chemist as non-metals, we find carbon and silicium—I prefer, on account of its stellar behaviour, to call it silicium, though it is old-fashioned—present in celestial phenomena; we have evidence of this in the fact that we have a considerable development of carbon in some stars and an indication of silicium in others. But these are the only non-metals observed. Now with regard to the metallic substances which we find, we deal chiefly with calcium, strontium, iron and magnesium; others are not absolutely absent, but their percentage quantity is so small that they are negligible in a general statement.

Now do these chemical elements exist indiscriminately in all the celestial bodies, so that practically, from a chemical point of view, the bodies appear to us of similar chemical constitution? No, it is not so.

From the spectra of those stars which resemble the sun, in that they consist of an interior nucleus surrounded by an atmosphere which absorbs the light of the nucleus, and which therefore we study by means of this absorption; it is to be gathered that the atmospheres of some stars are chiefly gaseous, *i.e.* consisting of elements we recognise as gases here, of others chiefly metallic, of others again mainly composed of carbon or compounds of carbon.

Here then we have spectroscopically revealed the fact that there is considerable variation in the chemical constituents which build up the stellar atmospheres.

This, though a general, is still an isolated statement. Can we connect it with another? One of the laws formulated by Kirchhoff in the infancy of spectroscopic inquiry has to do with the kind of radiation given out by bodies at different temperatures. A poker placed in a fire first becomes *red*, and as it gets hotter, *white*, hot. Examined in a spectroscope we find that the red condition comes from the *absence* of blue light; that the white condition comes from the gradual addition of blue as the temperature increases.

The law affirms that the hotter a mass of matter is the further its spectrum extends into the ultra-violet.

Hence the hotter a star is, the further does its complete or *continuous* spectrum lengthen out towards the ultra-violet, and the less is it absorbed by cooler vapours in its atmosphere.

Now to deal with three of the main groups of stars, we find the following very general result:—

Gaseous stars	Longest spectrum.
Metallic stars	Medium spectrum.
Carbon stars	Shortest spectrum.

We have now associated two different series of phenomena, and we are enabled to make the following statement:—

Gaseous stars	Highest temperature.
Metallic stars	Medium temperature.
Carbon stars	Lowest temperature.

Hence the differences in apparent chemical constitutions are associated with differences of temperature.

Can we associate with the two to which I have already called attention still a third class of facts?

Laboratory work enables us to do this. When I began my inquiries the idea was, one gas or vapour one spectrum. We now know that this is not true; the systems of bright lines given out by radiating substances change with the temperature.

We can get the spectrum of a well-known compound substance—say carbonic oxide; it is one special to the compound; we increase the temperature so as to break up the compound, and we then get the spectra of its constituents, carbon and oxygen.

But the important thing in the present connection is that the spectra of the chemical elements behave exactly in the same way as the spectra of known compounds do when we employ temperatures far higher than those which break up the compounds; and indeed in some cases the changes are more marked. For brevity I will take for purposes of illustration three substances, and deal with one increase of temperature only, a considerable one and obtainable by rendering a substance incandescent, first by a direct current of electricity, as happens in the so-called "arc lamps" employed in electric lighting, and next by the employment of a powerful induction coil and battery of leyden jars. In laboratory parlance we pass thus from the arc to the jar-spark. In the case of magnesium, iron and calcium, the changes observed on passing from the temperature of the arc to that of the spark have been minutely observed. In each, new lines are added or old ones are intensified at the higher temperature. Such lines have been termed *enhanced lines*.

These enhanced lines are not seen alone: outside the region of high temperature in which they are produced, the cooling vapours give us the cool lines. Still we can conceive the enhanced lines to be seen alone at the highest temperature in a space sufficiently shielded from the action of all lower temperatures, but such a shielding is beyond our laboratory expedients.

In watching the appearance of these special enhanced lines in stellar spectra we have a third series of phenomena available, and we find that the results are absolutely in harmony with what has gone before. Thus

Gaseous stars ..	Highest temperature...	Strong helium and faint enhanced lines.
Metallic stars ...	Medium temperature	Feeble helium and strong enhanced lines. No helium and strong arc lines.
Carbon stars ..	Lowest temperature...	Faint arc lines.

It is clear now, not only that the spectral changes in stars are associated with, or produced by, changes of temperature, but that the study of the enhanced spark and the arc lines lands us in the possibility of a rigorous stellar thermometry, such lines being more easy to observe than the relative lengths of spectrum.

Accepting this, we can take a long stride forward and, by carefully studying the chemical revelations of the spectrum, classify the stars along a line of temperature. But which line? Were all the stars, in popular phraseology, created hot? If so, we should simply deal with the running down of temperature, and because all the hottest stars are chemically alike, all cooler stars would be alike. But there are two very distinct groups of coolest stars; and since there are two different kinds of coolest stars, and only one kind of hottest star, it can not be merely a question either of a running up or a running down of temperature.

Many years of very detailed inquiry have convinced me that all stars save the hottest must be sorted out into two series—those getting hotter and those, like our sun, getting cooler, and that the hottest stage in the history of a star is reached near the middle of its life.

The method of inquiry adopted has been to compare large-scale photographs of the spectra of the differ

stars, taken by my assistants at South Kensington; the complete harmony of the results obtained along various lines of other work carries conviction with it.

We find ourselves here in the presence of minute details exhibiting the workings of a chemical law, associated distinctly with temperature; and more than this, we are also in the presence of high temperature furnaces, entirely shielded by their vastness from the presence of those distracting phenomena which we are never free from in the most perfect conditions of experiment we can get here.

What, then, is the chemical law? It is this. In the very hottest stars we deal with the gases hydrogen, helium, and doubtless others still unknown, almost exclusively. At the next lowest temperatures we find these gases being replaced by metals in the state in which they are observed in our laboratories when the most powerful jar-spark is employed. At a lower temperature still the gases almost disappear entirely, and the metals exist in the state produced by the electric arc. Certain typical stars showing these chemical changes may be arranged as follows:

Stars getting hotter.	Hottest stars.	Stars cooling.
	Bellatrix	
ζ Tauri		β Persei
Rigel		γ Lyra
α Cygni		Castor
γ Cygni		Procyon
α Orionis		Arcturus and Sun

This, then, is the result of our first inquiry into the existence of the various chemical elements in the atmospheres of stars generally. We get a great diversity, and we know that this diversity accompanies changes of temperature. We have also found that the sun, which we independently know to be a cooling star, and Arcturus, are identical chemically.

We have now dealt with the presence of the various chemical elements, generally, in the atmospheres of stars. The next point we have to consider is whether the absorption which the spectrum indicates for us takes place from top to bottom of the atmosphere, or only in certain levels.

In many of these stars the atmosphere may be millions of miles high. In each the chemical substances in the hottest and coldest portions *may* be vastly different; the region, therefore, in which this absorption takes place, which spectroscopically enables us to discriminate star from star, must be accurately known before we can obtain the greatest amount of information from our inquiries.

Our next duty then clearly is to study the sun—a star so near us that we can examine the *different parts* of its atmosphere, which we cannot do in the case of the more distant stars. By doing this we may secure facts which will enable us to ascertain in what parts of the atmosphere the absorption takes place which produces the various phenomena on which the chemical classification has been based.

It is obvious that the general spectrum of the sun, like that of stars generally, is built up of all the absorptions *which can make themselves felt* in every layer of its atmosphere from bottom to top, that is from the photosphere to the outermost part of the corona. Let me remind you that this spectrum is *changeless* from year to year.

Now sun-spots are disturbances produced in the photosphere; and the chromosphere, with its disturbances, called prominences, lies directly above it. Here, then, we are dealing with the lowest part of the sun's atmosphere. We find first of all that in opposition to the changeless general spectrum, great changes occur with the sun-spot period, both in the spots and chromosphere.

The spot spectrum is indicated, as was found in 1866, by the widening of certain lines; the chromospheric spectrum, as was found in 1868, by the appearance at the sun's limb of certain bright lines. In both cases the lines affected seen at any one time are relatively few in number.

In the spot spectrum, at a sun-spot minimum, we find iron lines chiefly affected; at a maximum they are chiefly of unknown or unfamiliar origin. At the present moment the affected lines are those recorded in the spectra of vanadium and scandium, with others never seen in a laboratory. That we are here far away from terrestrial chemical conditions is evidenced by the fact that there is not a gramme of scandium available for laboratory use in the world at the present time.

Then we have the spectrum of the prominences and the chromosphere. That spectrum we are enabled to observe every day when the sun shines, as conveniently as we can observe that of sun-spots. The chromosphere is full of marvels. At first, when our knowledge of spectra was very much more restricted than now, almost all the lines observed were unknown. In 1868 I saw a line in the yellow, which I found behaved very much like hydrogen, though I could prove that it was not due to hydrogen; for laboratory use the substance which gave rise to it I called helium. Next year I saw a line in the green at 1474 of Kirchhoff's scale. That was an unknown line, but in some subsequent researches I traced it to iron. From that day to this we have observed a large number of lines. They have gradually been dragged out from the region of the unknown, and many are now recognised as enhanced lines, to which I have already called attention as appearing in the spectra of metals at a very high temperature.

But useful as the method of observing the chromosphere without an eclipse, which enables us

"... to feel from world to world,"

as Tennyson has put it, has proved, we want an eclipse to see it face to face.

A tremendous flood of light has been thrown upon it by the use of large instruments constructed on a plan devised by Respighi and myself in 1871. These give us an image of the chromosphere painted in each one of its radiations, so that the exact locus of each chemical layer is revealed. One of the instruments employed during the Indian eclipse of this year is that used in photographing the spectra of stars, so that it is now easy to place photographs of the spectra of the chromosphere obtained during a total eclipse and of the various stars side by side.

I have already pointed out that the chemical classification indicated that the stars next above the sun in temperature are represented by γ Cygni and Procyon, one on the ascending, the other on the descending branch of the temperature curve.

Studying the spectra photographed during the eclipse of this year we see that practically the lower part of the sun's atmosphere, if present by itself, would give us the lines which specialise the spectra of γ Cygni or Procyon.

I recognise in this result a veritable Rosetta stone which will enable us to read the celestial hieroglyphics presented to us in stellar spectra, and help us to study the spectra and to get at results much more distinctly and certainly than ever before.

One of the most important conclusions we draw from the Indian eclipse is that, *for some reason or other*, the lowest hottest part of the sun's atmosphere does not write its record among the lines which build up the general spectrum so effectively as does a higher one.

There was another point especially important on which we hoped for information, and that was this. Up to the employment of the prismatic camera insufficient attention had been directed to the fact that in observations made by an ordinary spectroscope, no true measure of the height to which the vapours or gases

extended above the sun could be obtained; early observations, in fact, showed the existence of glare between the observer and the dark moon; hence it must exist between us and the sun's surroundings.

The prismatic camera gets rid of the effects of this glare, and its results indicate that the effective absorbing layer—that, namely, which gives rise to the Fraunhofer lines—is much more restricted in thickness than was to be gathered from the early observations.

We are justified in extending these general conclusions to all the stars that shine in the heavens.

So much then, in brief, for solar teachings in relation to the record of the absorption of the lower parts of stellar atmospheres.

Let us next turn to the higher portions of the solar surroundings to see if we can get any effective help from them.

In this matter we are dependent absolutely upon eclipses, and I shall fulfil my task very badly if I do not show you that the phenomena then observable when the so-called corona is visible, full of awe and grandeur to all, are also full of precious teaching to the student of science. This also varies like the spots and prominences with the sun-spot period.

It happened that I was the only person that saw both the eclipse of 1871 at the maximum of the sun-spot period and that of 1878 at minimum; the corona of 1871 was as distinct from the corona of 1878 as anything could be. In 1871 we got nothing but bright lines indicating the presence of gases; namely hydrogen and another, since provisionally called coronium. In 1878 we got no bright lines at all, so I stated that probably the changes in the chemistry and appearance of the corona would be found to be dependent upon the sun-spot period, and recent work has borne out that suggestion.

I have now specially to refer to the corona as observed and photographed this year in India by means of the prismatic camera, remarking that an important point in the use of the prismatic camera is that it enables us to separate the spectrum of the corona from that of the prominences.

One of the chief results obtained is the determination of the position of several lines of probably more than one new gas, which, so far, have not been recognised as existing on the earth.

Like the lowest hottest layer, *for some reason or other*, this upper layer does not write its record among the lines which build up the general spectrum.

General results regarding the locus of absorption in stellar atmospheres.

We learn from the sun, then, that the absorption which defines the spectrum of a star is the absorption of a middle region, one shielded both from the highest temperature of the lowest reaches of the atmosphere where most tremendous changes are continually going on, and the external region where the temperature must be low, and where the metallic vapours must condense.

If this is true for the sun it must be equally true for Arcturus, which exactly resembles it. I go further than this, and say that in the presence of such definite results as those I have brought before you, it is not philosophical to assume that the absorption may take place at the bottom of the atmosphere of one star, or at the top of the atmosphere of another. The *onus probandi* rests upon those who hold such views.

So far I have only dealt in detail with the hotter stars, but I have pointed out that we have two distinct kinds of coolest ones, the evidence of their much lower temperature being the shortness of their spectra. In one of these groups we deal with absorption alone, as in those already considered; we find an important break in the phenomena observed; helium, hydrogen and metals have practically disappeared, and we deal with carbon absorption alone.

But the other group of coolest stars presents us with quite new phenomena. We no longer deal with absorption alone, but accompanying it we have radiation, so that the spectra contain both dark lines and bright ones. Now since such spectra are visible in the case of new stars, the ephemera of the skies, which may be said to exist only for an instant relatively, and when the disturbance which gives rise to their sudden appearance has ceased, we find their places occupied by nebulae, we cannot be dealing here with stars like the sun, which has already taken some millions of years to slowly cool, and requires more millions to complete the process into invisibility.

The bright lines seen in the large number of permanent stars which resemble these fleeting ones—*new stars*, as they are called—are those discerned in the once mysterious nebulae which, so far from being stars, were supposed not many years ago to represent a special order of created things.

Now the nebulae differ from stars generally in the fact that in their spectra we have practically to deal with radiation alone, we study them by their bright lines, the conditions which produce the absorption by which we study the chemistry of the hottest stars are absent.

A new view of stars.

Here then we are driven to the perfectly new idea that some of the cooler bodies in the heavens the temperature of which is increasing and which appear to us as stars, are really disturbed nebulae.

What then is the chemistry of the nebulae? It is mainly gaseous; the lines of helium and hydrogen and the flutings of carbon, already studied by their absorption in the groups of stars to which I have already referred, are present as bright ones.

The presence of the lines of the metals iron, calcium, and probably magnesium, shows us that we are not dealing with gases merely.

Of the enhanced metallic lines there are none, only the low temperature lines are present, so far as we yet know. The temperature then is low, and lowest of all in those nebulae where carbon flutings are seen almost alone.

A new view of nebulae.

Passing over the old views, among them one that the nebulae were holes in something dark which enabled us to see something bright beyond, and another that they were composed of a fiery fluid, I may say that not long ago they were supposed to be masses of gases only, existing at a very high temperature.

Now, since gases may glow at a low temperature as well as at a high one, the temperature evidence must depend upon the presence of cool metallic lines and the absence of the enhanced ones.

The nebulae, then, are relatively cool collections of some of the permanent gases and of some cool metallic vapours, and both gases and metals are precisely those I have referred to as writing their records most visibly in stellar atmospheres.

Now can we get more information concerning this association of certain gases and metals? In laboratory work it is abundantly recognised that all meteorites (and many minerals) when slightly heated give out permanent gases, and under certain conditions the spectrum of the nebulae may in this way be closely approximated to. I have not time to labour this point, but I may say that a discussion of all the available observations to my mind

demonstrates the truth of the suggestion, made many years ago by Prof. Tait before any spectroscopic facts were available, that the nebulae are masses of meteorites rendered hot by collisions.

Surely human knowledge is all the richer for this indication of the connection between the nebulae, hitherto the most mysterious bodies in the skies, and the "stones that fall from heaven."

Celestial evolution.

But this is, after all, only a stepping-stone, important though it be. It leads us to a vast generalisation. If the nebulae are thus composed, they are bound to condense to centres however vast their initial proportions, however irregular the first distribution of the cosmic clouds which compose them; each pair of meteorites in collision puts us in mental possession of what the final stage must be. We begin with a feeble absorption of metallic vapours round each meteorite in collision; the space between the meteorites is filled with the permanent gases driven out further afield and having no power to condense. Hence dark metallic and bright gas lines. As time goes on, the former must predominate, for the whole swarm of meteorites will then form a gaseous sphere with a strongly heated centre, the light of which will be absorbed by the exterior vapour.

The temperature-order of the group of stars with bright lines as well as dark ones in their spectra, has been traced, and typical stars indicating the chemical changes have been as carefully studied as those in which absorption phenomena are visible alone, so that now there are no breaks in the line connecting the nebulae with the stars on the verge of extinction.

Here we are brought to another tremendous outcome, that of the evolution of all cosmical bodies from meteorites, the various stages recorded by the spectra being brought about by the various conditions which follow from the conditions.

These are shortly that at first collisions produce luminosity among the colliding particles of the swarm, and the permanent gases are given off and fill the interspaces. As condensation goes on, the temperature at the centre of condensation always increasing, all the meteorites in time are driven into a state of gas. The meteoritic bombardment practically now ceases for lack of material, and the future history of the mass of gas is that of a cooling body, the violent motions in the atmosphere while condensation was going on now being replaced by a relative calm.

The absorption phenomena in stellar spectra are not identical at the same mean temperature on the ascending and descending sides of the curve, on account of the tremendous difference in the physical conditions.

In a condensing swarm, the centre of which is undergoing meteoritic bombardment from all sides, there cannot be the equivalent of the solar chromosphere; the whole mass is made up of heterogeneous vapour at different temperatures, and moving with different velocities in different regions.

In a condensed swarm, of which we can take the sun as a type, all action produced from without has practically ceased; we get relatively a quiet atmosphere and an orderly assortment of the vapours from top to bottom, disturbed only by the fall of condensed metallic vapours. But still, on the view that the differences in the spectra of the heavenly bodies chiefly represent differences in degree of condensation and temperature, there can be, *au fond*, no great chemical difference between bodies of increasing and bodies of decreasing temperature. Hence, we find at equal mean temperatures on opposite sides of the temperature curve, this chemical similarity of the absorbing vapours proved by many points of resemblance in the spectra, especially the identical behaviour of the enhanced metallic and cleveite lines.

Celestial dissociation.

The time you were good enough to put at my disposal is now exhausted, but I cannot conclude without stating that I have not yet exhausted all the conceptions of a high order to which Fraunhofer's apparently useless observation has led us.

The work which to my mind has demonstrated the evolution of the cosmos as we know it from swarms of meteorites, has also suggested a chemical evolution equally majestic in its simplicity.

A quarter of a century ago I pointed out that all the facts then available suggested the hypothesis that in the atmospheres of the sun and stars various degrees of "celestial dissociation" were at work, a "dissociation" which prevented the coming together of the finest particles of matter which at the temperature of the earth and at all artificial temperatures yet attained here compose the metals, the metalloids and compounds.

On this hypothesis the so-called atoms of the chemist represent not the origins of things, but only early stages of the evolutionary process.

At the present time we have tens of thousands of facts which were not available twenty-five years ago. All these go to the support of the hypothesis, and among them I must indicate the results obtained at the last eclipse, dealing with the atmosphere of the sun in relation to that of the various stars of higher temperature to which I called your attention. In this way we can easily explain the enhanced lines of iron existing practically alone in Alpha Cygni. I have yet to learn any other explanation.

I have nothing to take back either from what I then said or what I have said since on this subject, and although the view is not yet accepted, I am glad to know that many other lines of work which are now being prosecuted tend to favour it.

I have no hesitation in expressing my conviction that in a not distant future the inorganic evolution to which we have been finally led by following up Fraunhofer's useless experiment, will take its natural place side by side with that organic evolution the demonstration of which has been one of the glories of the nineteenth century.

And finally now comes the moral of my address. If I have helped to show that observations having no immediate practical bearing may yet help on the thought of mankind, and that this is a thing worth the doing, let me express a hope that such work shall find no small place in the future University of Birmingham.

DIFFUSION IN RELATION TO WORK.

IN this month's *Philosophical Magazine* Mr. A. Griffiths has an interesting paper on diffusion convection, in which he suggests an indirect method of measuring rates of diffusion of liquids, and concludes with the following deduction from the fact that diffusion sometimes produces convection currents and sometimes does not:—"Does not this indicate that the heat produced on mixing a solution with water depends on how the mixing takes place? Is the matter connected with a sort of surface-tension existing in the spaces between a strong and a weak solution?"

Mr. Griffiths does not seem to have observed that his investigation applies quite well to gases as to liquids, and that his indirect method of measuring rates of diffusion is applicable to gases. In the case of gases there can be sensible surface-tension, and, as the theory of diffusion in gases is quite simple, there is no serious difficulty in seeing how there is a difference between different ways of mixing them.

It is generally known that two different gases may be mixed by irreversible, or by, at least, partially reversible,

processes. They may be allowed to diffuse freely into one another, or may be separated by a porous partition. In the latter case a considerable difference of pressure may be produced between different parts of the space containing them, and this difference of pressure can be used to do work. The final condition in this case is, of course, cooler than if the gases did no external work. In the same way a solution diffusing into water may do so without doing external work, or it may do so by a reversible process, through a semi-permeable diaphragm, producing considerable differences of pressure, which may be used to do work. The final condition in this latter case would, of course, be cooler than in the former case of inter-diffusion without doing external work. Now whenever convection currents are produced, these are to some extent reversible. We might put vanes into the liquid to be moved by the currents and to do work outside the liquid, and by reversing this we would reverse the convection currents. Hence any method of mixing in which convection currents are produced, which do work or produce heat outside the liquid, will necessarily produce less heat in the liquid than a method of mixing in which there are either no convection currents, or these produce heat by viscous flow inside the liquid.

That we can, at pleasure, either use the diffusion of two gases into one another to do external work or not, is really not different from the case of a single gas expanding into a larger volume. We may do work by this expansion and cool the gas, or we may allow the gas, as in Joule's experiments, to expand into a larger volume without doing external work, and in this case there is only a very small change of temperature.

In these cases it is a question of change of entropy in the system, which can either be effected by an irreversible process in which no work is done, or by a variety of other processes, more or less reversible, in which the more reversible they are the more work can be done. In the case of producing convection currents, or, in general, of diffusion of a heavy fluid upwards into a lighter one, the amount of heat produced would not be exactly the same as if gravity were not acting: the centre of gravity of the system is raised by diffusion. Now in Mr. Griffiths's case, and in the case of diffusion currents generally, this raising of the centre of gravity takes place throughout part of the space considered by diffusion, and the centre of gravity is continually falling down again in the convection currents. Hence the work that can be done by the convection currents is part of the work that was done by diffusion against gravity. In the case of diffusion without convection currents, we might use the whole of this work done against gravity, by which the centre of gravity of the system has been raised, to do external work. If, for example, the containing vessel were supported at its centre of gravity, in the unmixed condition, the centre of gravity would, after diffusion, be above the point of support, and the vessel and its contents might be arranged to turn round the support doing work during the fall of the centre of gravity to its original level. Another way of utilising the rise is to allow the fluid to flow into another broader vessel until its centre of gravity has returned to the original level. The thing to be specially observed is, that the amount by which the centre of gravity is raised depends entirely upon the shape of the vessel. If it be tall, the centre of gravity will be raised a great deal; while if it be low, the centre of gravity will be only slightly raised. By causing diffusion to take place in a tall thin vessel, the final temperature will be lower than in a broad low one, not on account of any superficial tensions, but on account of the work done against gravity. In Mr. Griffiths's methods diffusion is continually taking place along tall thin vessels, and convection currents lowering the centre of gravity again by flow into broad ones. Geo. Fras. FitzGerald.

THE EXPECTED METEORIC SHOWER.

The imminent return of the Leonids once more attracts us to prepare for their observation and discuss their phenomena. The circumstances this year will be much more favourable, all round, than they were in 1897, but our prospects of witnessing a really brilliant return appear to be somewhat slender. No doubt, on the morning of November 15, meteors will appear in sufficient abundance to gratify moderate expectation, but the conditions scarcely warrant the influence that we are to have a grand display. We must wait until 1899 or 1900 to see the shower at its best. In 1832 it is true Dawes saw many astonishingly fine meteors; and well he might, for the parent comet of the Leonids was very near that section of the orbit which the earth intersected in the year named. In 1865 we passed through a region of the stream some way in advance of the comet, for the latter arrived at its descending node about two months after the earth had crossed the point. There was nothing deserving the title of a great meteoric shower on that occasion. But there was certainly an unusual number of fine shooting-stars, the majority of the objects observed being as bright as, or brighter than, stars of the first magnitude. At Greenwich it was estimated that more than 1000 meteors must have been visible on the morning of November 13. Mr. Knott, observing at Cuckfield in Sussex, estimated the number as more than one per minute for two observers. According to some other accounts the richness of the display far exceeded this, for a captain of a British ship, near the West Indies, wrote to say that the heavens were in a blaze with shooting-stars from 8 p.m. on November 12 to 5 next morning. But accounts of the latter description are often exaggerated, and it is always unsafe to draw any definite conclusions from them.

At the approaching return the earth crosses the meteoric orbit still further in front of the comet than it did in 1865. In fact the comet will have five or six months' journey to run at its highest rate of speed before it reaches its descending node. This is not allowing for any perturbations which the comet has experienced since 1866, and there is no doubt that some serious disturbances have been introduced, particularly, by Saturn and Jupiter.

It seems that in July 1895, the comet approached to within 45 millions of miles of Saturn, and though the former has not passed so near as this to Jupiter, both planets have exercised a very appreciable influence both on the comet and its associated meteoric stream. Dr. Berberich gives these conclusions in an important paper published in *Ast. Nach.*, 3526, and states as a result of his investigation that the meteor shower will appear 21 hours late in 1898 and 26 hours behind time in 1899. The comet of Tempel (1866 I.) is not, according to Dr. Berberich, likely to be observed at the ensuing return to perihelion, as it will present itself under unfavourable conditions. Dr. Berberich's results are interesting as showing the necessity for expecting the meteors on the mornings of the 15th and 16th, rather than on earlier dates. His conclusions seem strengthened by the fact that last year a pretty strong shower of Leonids was witnessed just before sunrise on the morning of the 15th, whereas very few were seen on the previous morning.

Under all the circumstances a very rich shower can hardly be expected. Our historical records do not warrant the assumption that the section of the orbit in the van of the comet is thickly strewn with meteoric particles. In the comet's wake, for an enormous distance, the material appears to be densely distributed. This was sufficiently attested by the succession of three brilliant displays of 1866, 1867 and 1868.

Meteoric and cometary phenomena are, however, somewhat unstable in character, and certainly variable

in their manifestations. They are quite capable of giving surprises. More meteors may now precede the cometary nucleus than the number there a generation ago, though the period is a comparatively short one, and comprises only one revolution of the swarm. There is one highly favouring circumstance this year, and that is the absence of moonlight. If the atmosphere is also free from cloud, the nights following the 14th and 15th will afford a splendid opportunity both for the visual observer and the photographic manipulator. I believe the night of the 14th will turn out the most productive, and especially the latter part of it forming the few hours before sunrise on the 15th.

Ordinary observers, while watching the meteors, will be usefully employed in determining, as accurately as possible, the time when the maximum in point of numbers is reached. The meteors should be counted at short intervals, and the horary rates of apparition during the night ascertained. The position of the radiant point is already well known; a mean of seventy values places it at R.A. 149° 28′, Dec. 22° 52′+, so that it is centrally within the curve of the "Sickle" of Leo, and close to the star *x* Leonis (Mag. 5·7) of Bode or Piazzi IX. 230.

It is especially to be hoped that attempts to obtain determinations of the radiant point by photography will be successful. The want of success in previous efforts has been very disappointing. Thus Mr. W. H. Pickering writes in *Popular Astronomy*, that on November 13, 1897, though he exposed eighty-one plates, only two meteor trails were secured. No doubt there are difficulties to be overcome; but as soon as the photographic method can be successfully utilised on a great meteoric shower, and a sufficient number of trails obtained to indicate a really good radiant, the visual method will have to be abandoned in its favour. It will be a long time hence, if ever, that the photographic plate will supersede the eye in ordinary meteoric observation; but in the case of a display such as the Leonids can furnish, the new method seems to promise well as regards the great accuracy of its records, though hitherto the latter have been exceedingly meagre.

W. F. DENNING.

MR. LATIMER CLARK, F.R.S.

ON Sunday, October 30, Mr. Latimer Clark, F.R.S., died very suddenly at his residence at Kensington, in his seventy-sixth year. His loss will be keenly felt by the various learned societies of which he was a member; especially by the Institution of Electrical Engineers, who claimed him as a founder and past-president. The name of Latimer Clark is familiar to all who during the past half-century have watched the various phases of progress in the science and practice of electrical engineering. Submarine cable engineers associate it with inventions that relate to every branch of their profession, from the process of sheathing the "core," to the last refinements of testing; and the constructors of land-lines still recognise the "Latimer Clark" double-bell insulator as a type universally accepted His book, written in conjunction with the late Robert Sabine, on "Electrical Tables and Formulae," is to be found in every electrician's library, and in every cable-factory and telegraph testing-station in the world; his "approximate method" of fault-testing on submarine cables, by applying two successive potential differences, was an important step in the development of the modern empirical but nevertheless remarkably exact system of testing by two applications of different battery power; and his test of the electrical condition of "joints" in cable core is, under the name of "the accumulation method," still in daily use at cable works and on board ship. Another of his valuable contributions to telegraph progress is his study of the errors due to the inductive action of a galvanometer-needle upon its own coil when using shunts of different values, in a series of comparative "discharges." To this must be added his important modification of Poggendorff's method of comparing electro-motive forces, and the introduction, with this test, of the well-known potentiometer that bears his name. This instrument is perhaps associated in our minds rather with the laboratory than with the cable-testing room; and, moreover, it is here in the physical laboratory that we discover what is undoubtedly the best-known of Mr. Latimer Clark's inventions: the zinc-mercury standard cell. The vast amount of work that has been done, the modifications suggested, and the pages written in regard to this small apparatus, might well lead the uninitiated to suppose that it contains some potent *talia azman* to which electricians are for ever looking for revelation and mysteries. It happens to be merely the electricians' practical standard of potential-difference; but to those who care to study such things, it is still full of the mystery of the origin and meaning of contact electro-motive force.

The written and legendary history of the early days of electric telegraphs, over land and under sea, shows how closely Mr. Latimer Clark was associated with this work, both at home and abroad. Success did not always reward the efforts of the telegraph engineer, even in those times; for although commercial competition did not then exist to its present extent, there were all the difficulties of inexperience to be fought against. Success as regards the technical details of construction and working, came sooner than financial success. Estimating the cost of land-lines was beset with the almost insurmountable difficulties of transport and commissariat in countries savage and unexplored. Mr. Latimer Clark, in those pioneer days, was one upon whom the brunt of these reverses at first fell somewhat heavily. All honour to him and to his comrades; they fought for the greatest achievement in the world's history. R. A.

THE TREASURERSHIP OF THE ROYAL SOCIETY.

IN the list of the proposed Council of the Royal Society for the ensuing year will be noticed a change in the Treasurership. Sir John Evans, K.C.B., retires, and the Council proposes to replace him by Mr. Kempe. Concerning this proposal the following letter has appeared in the *Times*:—

Sir,—The list of officers of the Royal Society proposed for election at the general meeting at the end of this month, published in the *Times* of Friday last, will not surprise any Fellow who is acquainted with the inner history of the society during the past few years, but in the change of *personnel* of the treasurership suggested it will astonish the great body of Fellows and may well arouse misgiving, if not anxiety, in the mind of the public—misgiving not to be lessened by the veiled *communiqué*, intended, apparently, to allay apprehension, which appeared in a certain section of the London press on Saturday.

The treasurer of the society is, like the two secretaries, a permanent officer, and these three officers have, therefore, a dominant influence in the affairs of the society, the treasurer having place by custom, at any rate next to the president.

Outside the society, too, in those responsible relationships with the public which the position of the society, as representative of science, engenders these permanent officials have a voice, consultative or executive, for the society. The choice, then, of treasurer is a matter of immediate moment to a wider circle than the Fellows of the society, and the nomination to the office by the present officers and council may therefore be fairly submitted for criticism in the *Times*. It is an open secret that an influential protest failed to arrest it.

Assuredly the roll of the society furnishes in abundance names of Fellows well tried in its work and veterans in the cause of science from which, as heretofore, a selection of treasurer could be made which would not only safeguard the interests of the society but also be a guarantee to the public that the best blood of the society was being devoted to the

services it justly claims. Why, then, should choice fall, as it has fallen, upon a comparatively junior Fellow who, whatever his scientific merit, is unknown as a leader in science? Is there no room at present for another planet in the official firmament? Whatever be the cause, a large number of Fellows view with dismay this departure from the wise tradition which required pre-eminence amongst the eminent in science as the passport to the position of officer in the Royal Society, and to many the nomination, if it be confirmed, will appear a damaging blow to the society's prestige.

It may be that notwithstanding the protest referred to those responsible for the nomination do not realise its full significance and the feeling it has stirred. If this be as strong as it appears there is provided by the constitution of the society at the general meeting on the 30th an opportunity for its expression.

I am, &c., F.R.S.

It may be remarked that on looking back into the history of the Society, we find the last four Treasurers to have been—

General Sabine	1850
Prof. W. A. Miller	1861
Dr. Spottiswoode	1870
Sir John Evans	1878

NOTES.

THE Royal Society's medals have this year been adjudicated as follows:—Copley Medal, Sir William Huggins, F.R.S.; Royal Medals, Rev. John Kerr, F.R.S., Mr. Walter Gardiner, F.R.S.; Rumford Medal, Prof. Oliver Lodge, F.R.S.; Davy Medal, Prof. Johannes Wislicenus, For. Mem. R.S.; Darwin Medal, Prof. Karl Pearson, F.R.S.

AT the anniversary meeting of the Royal Society on November 30, the following names will be recommended for election into the Council of the Society for the year 1899:—President: Lord Lister. Treasurer: Alfred Bray Kempe. Secretaries: Prof. Michael Foster, Prof. Arthur William Rücker. Foreign Secretary: Sir Edward Frankland, K.C.B. Other members of the Council: Prof. Thomas George Bonney, Captain Ettrick William Creak, R.N., Prof. Daniel John Cunningham, Prof. James Dewar, Prof. William Dobinson Halliburton, Prof. William Abbott Herdman, Victor A. H. Horsley, Joseph Larmor, Prof. Nevil Story Maskelyne, Sir Andrew Noble, K.C.B., Prof. Edward Bagnall Poulton, Dr. William James Russell, Prof. Arthur Schuster, Dr. Dukinfield Henry Scott, Dr. George Johnstone Stoney, Prof. Joseph John Thomson.

PROF. OSTWALD will give an address at University College, Gower Street, on Monday next, November 14, at 5 p.m., in the Chemical Theatre. Visitors are invited.

THE appointment of a Commission, consisting mainly of scientific experts, to report upon the plague in India, has already been referred to in these columns (vol. lviii. p. 626). We now learn that Dr. Thomas R. Fraser, F.R.S., Professor of Materia Medica and Clinical Medicine at Edinburgh University, has accepted the duty of president, and with him will be associated two other scientific experts, Dr. Wright, Professor of Pathology at the Army Medical School, Netley, and Dr. Rüffer, who has been for some time head of the Egyptian Sanitary Department at Cairo. Two officers of the Indian Civil Service, Mr. J. P. Hewett, and Mr. A. Cumine, both of whom have had much to do with recent plague affairs in India, have also been appointed to the Commission by the Government of India. The scope of the Commissioners' inquiries will include (1) the origin of the different outbreaks of plague; (2) the manner in which the disease is communicated; (3) the effects of certain prophylactic and curvative serums that have been tried or recommended for the disease. The members of the Commission will reach Bombay towards the end of the present month.

MR. CECIL B. CRAMPTON, of the University of Edinburgh, has been appointed to the position of assistant-keeper in the geological department of the Manchester Museum, Owens College, in succession to Mr. Herbert Bolton.

AT the anniversary meeting of the Mineralogical Society, to be held on Tuesday next, November 15, the election of officers and Council will take place. Prof. A. H. Church, F.R.S., has been nominated president, and Prof. G. D. Liveing, F.R.S., and Dr. Hugo Müller, F.R.S., vice-presidents.

WITH reference to Dr. Calmette's gift of 10,000*l.* to the Pasteur Institute at Lille, mentioned last week, the *British Medical Journal* states that, according to the terms of the deed of gift, the money is to be applied provisionally to the defraying of building expenses till the Municipal Council is in a position to vote the sums required for that purpose. The money is then to be employed in the purchase of material for new researches, or for the maintenance of young men of science who wish to make original researches in the laboratory. Dr. Calmette states that the money which he has thus generously bestowed, represents the profits accruing to him from the application of one of his discoveries in a large distillery at Seclin.

THE new session of the Royal Geographical Society will commence on Monday next, November 14, when addresses upon the subject of a British Antarctic expedition will be given by the President and others. At a meeting on November 28, Mr. C. W. Andrews will give an account of a year's work on Christmas Island. Other papers which are announced are the following:—"Exploration in the Caroline Islands," by F. W. Christian; "Lake Rukwa and Central Africa," by L. A. Wallace; "In Search of Mount Hooker and Mount Brown in the Canadian Rockies," by Dr. Norman Collie, F.R.S.; "Oceans and Continents," by Dr. J. W. Gregory; "Atlantic Highlands of the United States," by Prof. W. M. Davis; "Exploration in Sokotra," by Dr. H. O. Forbes.

DR. H. C. SORBY, F.R.S., who last year completed fifty years' connection with the Sheffield Literary and Philosophical Society, during which period he on several occasions filled the presidential chair, has just received a gratifying testimony of the esteem in which he is held locally as well as in the broad world of science. His admirers have had his portrait painted, and presented it to him with an illuminated address on Tuesday in last week. The portrait represents Dr. Sorby seated, and in his scarlet academic gown. The inscription at the foot of the frame is as follows:—"H. Clifton Sorby, LL.D., F.R.S. (1847–1897). This portrait was painted to celebrate Dr. Sorby's fifty years' connection with the Sheffield Literary and Philosophical Society, and to commemorate his world-wide scientific reputation. Funds for the purpose were provided by subscription amongst the proprietors and members of the Society. The artist was Mrs. M. L. Waller, and the presentation was made on behalf of the subscribers by the Lord Mayor of Sheffield on November 1, 1898."

THE first meeting of the new session of the Society of Arts will be held on Wednesday next, November 16, when an address will be delivered by Sir John Wolfe Barry, K.C.B., F.R.S., Chairman of the Council. Among the subjects of papers to be read before Christmas are: "Long Distance Transmission of Electric Power," by Prof. George Forbes, F.R.S.; "Photographic Developers and Development," by Mr. C. H. Bothamley. The papers for meetings after Christmas include: "Tuberculosis in Animals," by Mr. W. Hunting; "Canals and Inland Navigation in the United Kingdom," by Mr. L. F. Vernon-Harcourt; "Preservation of Timber," by Mr. S. B. Boulton; "Electric Traction and its Application to

Railway Work," by Mr. Philip Dawson; "Coal Supplies," by Mr. T. Forster Brown; "Wireless Telegraphy," by Mr. W. H. Preece, C.B., F.R.S.; "Leadless Glazes," by Mr. Wilton P. Rix. The following courses of Cantor lectures will be delivered: "Acetylene," by Prof. Vivian B. Lewes; "Bacterial Purification of Sewage," by Dr. Samuel Rideal; "Cycle Construction and Design," by Mr. Archibald Sharp; "Leather Manufacture," by Prof. Henry R. Procter.

Writing in the *Chemical News* "On the supposed new gas, Etherion," described by Mr. Charles F. Brush at the recent Boston meeting of the American Association, Sir William Crookes concludes as follows:—"On the evidence at present available, I consider it more probable that etherion is water vapour than that it is a new elementary gas, and this is corroborated by the observations made by Mr. Brush, that etherion is absorbed by phosphoric acid and soda-lime, as well as by the powdered glass from which it has previously been driven off by heat."

Mr. John S. Budgett, who accompanied Mr. Graham Kerr in his recent successful expedition to Paraguay, has left England, under instructions of the Zoological Society, for a winter visit to the Gambia, in order to obtain information concerning the Antelopes and other larger mammals of that Colony. Mr. Budgett will also make a collection of the fishes of the River Gambia, concerning which little is at present known, and of the other zoological products of the district.

The expedition of Mr. Harrington and Dr. Hunt, of Columbia University, New York, to Egypt, referred to last week, resulted in bringing back an admirable collection of Nile fishes, and other zoological materials, but was not successful in its chief object, which was to obtain a set of the embryonic stages of *Polypterus*. Although these naturalists remained in the Delta until August 30, and adult specimens of this fish were obtained as late as that date, the eggs were still immature; so that the important question of the nature of development of *Polypterus* still awaits investigation.

Mr. Stanley S. Flower, lately curator of the Royal Museum, Bangkok, has been appointed director of the Zoological Gardens at Gizeh, Cairo, and has arrived there from Siam to take up his appointment. Mr. Flower, on his voyage westward, brought with him, as a present to the Zoological Society of London, a young Siamang (*Hylobates syndactylus*), which is believed to be the first specimen of this rare ape that has ever reached Europe alive. In 1830 the late Dr. George Bennett started from Singapore, with a living Siamang, which he intended to bring to the Society, but it unfortunately died on its way home.

A new Natural History Museum was opened at King Williams Town, Cape Colony, on October 5. At the conversazione, subsequently held, an address was given by Mr. W. L. Sclater, director of the South African Museum, Capetown. Mr. Sclater, after speaking of museums in general and their origin, gave an account of their introduction into South Africa in 1856 by the foundation, under the governorship of the late Sir George Grey, of the South African Museum at Capetown. Not long afterwards the Albany Museum at Grahamstown was instituted with the object of illustrating the natural products of the eastern provinces of the Colony. There are also museums in South Africa at Port Elizabeth, Bloemfontein, Pretoria, Maritzburg and Durban.

Many students of science will regret to see the announcement that *Science Progress* comes to an end with the number just published. The valuable character of the contributions which have appeared in that magazine since the first number was published in March 1894, are well known in the scientific world; and it is a little disappointing to the publishers to have to confess that there is not sufficient demand for such literature to justify them in continuing to issue it. It is to be regretted that a periodical of this kind, containing articles which assist the advance of scientific knowledge, should have to cease for want of financial support.

Captain J. W. Maxwell Carroll has sent to the *Geographical Journal* (November) a few interesting particulars with reference to ancient stone circles discovered by him in the neighbourhood of Lamin Koto, on the right bank of the Upper Gambia. The stones are in very good preservation, and are regarded with respect by the natives. Prayers are offered in their vicinity on feast days during Ramadan by the Almame, or high priest. The diameter of the circle of stones is eighteen feet, and the stone at which the priest stands is a few feet to the east of the circle. Stone circles were also found by Captain Carroll at Chamen and Palellan. At the latter place a large rectangular stone, twelve feet by four, was discovered. Its height was six feet at one end and four at the other, and its shape suggested that it had been used as a sacrificial altar.

In the *Zeitschrift der Gesellschaft für Erdkunde* we notice, besides minor articles, an account by Dr. C. Lauterbach of the geographical results of the expedition to Kaiser Wilhelm's Land, and a paper, by Dr. Meinardus, on the relation between the winter climates of central and north-western Europe and the waters of the North Atlantic. The latter is an extension of the author's recent paper in the *Meteorologische Zeitschrift*, discussing the observations of Pettersson and Dickson as a possible basis for long-period weather forecasting.

In our issue of September 29 last, we very briefly referred to Dr. Köppen's chart of yearly isotherms and isabnormals of the sea surface. This chart, together with a discussion of its chief features, is reproduced in *Globus* of the 15th ult. The chart shows, in addition to the isotherms, those districts where a temperature anomaly of more than 2° C. exists: the areas where the water is too cold are shaded blue, and those which are too warm are shaded red, while the districts which are thermically neutral are left unshaded. It is seen that between latitude 0° and 40° S., cold currents extend like long tongues from the west coast of South Africa and South America towards the west, while to the north of the equator analogous currents are developed to a much less extent; on the coast of the Sahara the sea-temperature is only slightly below the normal value of the latitude. On the western sides of the oceans, in similar latitudes, there exist warm currents trending northwards. In the South Atlantic the warm and cold currents are nearly equalised. In the South Pacific, the cold current, and in the South Indian Ocean, the warm current, preponderates. This latter feature especially occurs in the northern hemisphere, and more particularly so in the North Atlantic. It is also seen that an area of cold water occurs on the western edge of the warm currents, and between them and the continents, where the latter stretch northwards as far as the zone of westerly winds, viz. on the east coasts of Asia, North and South America. There are many other points of interest, to which we are unable to allude at present.

The Deutsche Seewarte has recently published its twentieth annual report, for the year 1897. The death of Captain Seemann, on September 24 of that year, has been a great loss to the department, as he had for a long time devoted himself to the study and practice of weather telegraphy. A conference of the heads of German meteorological institutions was held at the Seewarte in October 1897, at which special attention was given to the organisation of the meteorological service; a report of

the proceedings has been published. During the year, 283 merchant ships were supplied with registers, and 794 logs were received; the majority of the observations were made in the North Atlantic, but the other oceans are also fairly represented. The observations for the North Atlantic are chiefly utilised in the preparation and publication of results for one-degree squares and of daily synoptic weather charts, both of which works we have already noticed. The Seewarte undertakes the verification of a large number of instruments; it also publishes the results of scientific investigations in the work entitled *Aus dem Archiv der Deutschen Seewarte*. This valuable publication has also already been referred to in our columns. The collection of observations from distant stations is a useful addition to the various other labours of the institution, but the publication of the results has been temporarily retarded by pressure of other work.

PROBLEMS on the deformation of an elastic ellipsoid are known to require for their complete solution functions in working with which a fairly good mathematician may easily go out of his depth. MM. Eugène and François Cosserat, however, send us a note, reprinted from the *Comptes rendus*, in which they show that the particular solutions corresponding to harmonics of the second and third orders, assume comparatively simple forms.

A HIGHLY interesting note by Prof. B. Grassi, on the connection between mosquitoes and malaria, appears in the *Atti dei Lincei*, vii. 7. The theory that these insects disseminate the germs of malaria by their punctures, seems to have been first brought into notice by Laveran; but Dr. Grassi for a long time had doubts on the subject, owing to the absence of malaria from certain districts where mosquitoes abound; Schwetzingen, in Germany, being a notable instance. A careful classification of the various species of gnat found in different districts has now led him to the conclusion that, while certain kinds are not confined to malarious regions, the distribution of others coincides very closely with the distribution of the disease. The common *Culex pipiens* is to be regarded as perfectly innocuous; being most abundant in places from which malaria is absent. On the other hand, a large species (*Anopheles claviger*, Fabr.), known in Italy as "zanzarone," or "moschino," is constantly found associated with malaria, and is most abundant where the disease is most prevalent. In illustration of this fact Dr. Grassi enumerates a number of striking coincidences in which both gnats and the disease are confined to the same limited and well-defined regions. Another disseminator of malaria is *Culex penicillaris*, and the author gives authentic instances in which recorded punctures of this gnat have been followed by febrile symptoms. Certain other species of *Anopheles* are confined to the marshy regions where malaria rages, and two or three additional species of *Culex* are suspected, but on less conclusive evidence. The fact is mentioned that *Anopheles claviger* confines its attacks chiefly to the evening after sunset, and in this circumstance the old superstition that it is dangerous to fall asleep in malarious regions just after sunset, finds a ready explanation. These facts open up new hopes that it may be possible to stamp out malaria by taking proper steps for the destruction of mosquito larvae in districts where dangerous species abound.

THE annual report for 1896-97 on British New Guinea (-9046-5) contains only a few notes of interest to science. The reports of visits of inspection are not so full as in previous years, and there are the ominous footnotes "not printed" relating to several documents of interest. The natives of the lower villages of the Mambare River are very untrustworthy. It was during the visit to this district that the inspectors "for the first time learned how the natives make the hole for the reception of the wooden handle in stone clubs. It is chipped out by means of a small stone about the size and nearly of the shape of a rifle bullet." On the crossing of the Chirima they were visited by about one hundred natives from the village of Neneba. They are the only tribe that actually live on a spur of Mount Scratchley. They are somewhat darker in tint than the coast people, but distinctly lighter than the average Fly River man. They are of fair size and wiry in build. No wavy-haired native was seen in that part of the country, and young men wear the eyebrows, while the elders have whiskers. The features are good and not irregular. The men wear the T-bandage, and the women, in addition to this, wear a petticoat and a mantle. The chief ornaments are earrings made of lizards' tails, and cigarette-holders carried in the lobe of the ear. They had the bow and arrow, and stone clubs, but, like many other bow and arrow tribes, they have no pottery. The floors of their houses are six or eight feet above the ground. At the village of Gosisi, on the Vanapa, the natives did not appear to know of any place or people on the other side of the Owen Stanley range. The men of these tribes have remarkable physical proportions and strength.

AN interesting pamphlet upon the temperance question, from the pen of Dr. Archdall Reid, has just reached us. It is entitled "The Temperance Question from a Biological Standpoint." The author bases his theories and conclusions upon Weissmanism, viz. upon the assumption that inborn or congenital characters alone are transmitted to the offspring, acquired characters not being transmitted. Man is still undergoing evolution at the present day, and this, according to the author, mostly consists in the acquisition by him of immunity against disease or the effect of powerful drugs, including harmful narcotics. Alcohol is a harmful narcotic; from this it follows that one of the directions which the evolution of man is taking at the present day is the acquisition of immunity against alcohol, and this takes the special form of a diminution of the "normal" craving for alcohol. According to Dr. Reid the longer a race has had alcohol, and the easier and more abundant its supply, the more sober it is. For instance, the grape-growing southern Europeans are at the present time more sober than the races of northern Europe, where alcohol is more difficult to obtain, although formerly they were quite as drunken. They have become now immune to alcohol. The method by which this immunity has come about is naturally, from the point of view of the temperance reformer, of the utmost importance. Since, if it could only be imitated successfully, the temperance question would be solved. According to Dr. Reid this diminution of the craving for alcohol has been produced by the action of natural selection working in the presence of an abundant supply of the harmful substance in question. Any cause which reduces the supply of alcohol, or in any way increases the difficulty of obtaining it, in that it hampers the action of natural selection, tends to perpetuate drunkenness rather than to produce temperance. This truly dreadful picture of the world, or rather all races not yet immune, becoming "thoroughly drunken before they can hope to become thoroughly sober," can, to some extent, be mitigated by artificial selection. The innate drunkard, when found out by letting everybody have free access to alcohol, must be treated as a lunatic, and above all not be allowed to procreate. By this means the alcohol tainted "germ plasm" will finally be eliminated, and the race will become immune to alcohol.

THE older entomologists used to complain that the *Lepidoptera* were a peculiarly difficult order to classify, owing to the want of any salient characters; but now that the details of their structure are more minutely studied, the difficulty is rather to decide on the importance to be attached to the structure of particular organs. Even the eggs are now taken into account in classification, and also the larvae in their various stages, for the earlier stages often possess characters of importance, throwing

much light on the real affinities of the insects, which characters disappear in the half-grown or full-grown larva. The organs of the perfect insects are also receiving much attention from various entomologists who interest themselves in morphology; and two years ago Dr. Enzio Reuter, of Helsingfors, published an elaborate account of the structure of the palpi in butterflies; while in the last part of *Novitates Zoologicae*, the organ of the Tring Museum, Dr. K. Jordan has published a long and interesting article on the antennae of butterflies, dealing especially with the structure of the scales, sense-hairs, setiferous punctures and sense-bristles in the various families of butterflies, and, incidentally, in some moths. As is generally the case in such inquiries, "we learn that an antennal organ or structure is variable in one family, while it is relatively constant in other groups." We have not space to notice Dr. Jordan's remarks on the bearings of his inquiries on the phylogeny and classification of butterflies, for which we must refer our readers to the paper itself.

IN the same part of the *Novitates Zoologicae*, Dr. Jordan replies to some severe criticisms made by the late Prof. Eimer on the views put forward by the Hon. Walter Rothschild and Dr. Jordan on the classification of the *Papilionidae*. We cannot enter into the controversy; but may say that Dr. Jordan holds that Prof. Eimer was himself in error, owing to want of sufficient materials on which to base trustworthy conclusions.

MESSRS. OLIVER AND BOYD, Edinburgh, will, early in 1899, publish a book containing a biographical sketch of the late Mr. James Shaw, Tynron, and selections from his prolific writings on scientific, antiquarian, rural and literary subjects. Two hundred and fifty copies have already been subscribed for, and the material is now being prepared for press by Prof. Robert Wallace, University, Edinburgh, to whom all communications on the subject should be addressed.

A CONSIDERABLE space in the *Journal of Horticulture* for October is occupied by several papers on perfumes, by Mr. F. W. Burbidge. He gives a long list of perfumes and essential oils, and of the plants from which they are obtained, and a copious bibliography of the subject. A description and drawing is also given of the late Mr. A. Smee's apparatus contrived for condensing the perfume from fresh flowers; and reference is made to the antiseptic properties of perfumes, and to their remarkable power, as described by Prof. Tyndall, of absorbing heat from the atmosphere. The burning of perfumes or incense in churches, hospitals, &c., had undoubtedly originally a hygienic purpose. The Rev. G. Henslow gives a paper on the advantages to gardeners of a knowledge of vegetable physiology; and Mr. F. Enock one of his entertaining papers, very well illustrated, on insect blights and blessings. Mr. F. M. Bailey adds three new species of *Nepenthes* to the flora of Queensland, the pitchers of which are figured.

A VOLUME containing reports of experiments on the manuring of oats, hay, turnips, and potatoes, conducted in 1897 on farms in the south-west and centre of Scotland, under the direction of the agricultural department of the Glasgow and West of Scotland Technical College, has just been published.

THE following announcement is made in the *British Journal of Photography*:—"M. Berthiot, the well-known optician of Paris, has constructed a new 'satz' or casket of wide-angle lenses. It contains four single lenses; composed of three elements that have 24, 24, 31 and 39 cm. foci respectively, and can be used as single lenses, or combined they give 12, 16, 16 and 17·5 cm. foci lenses. On the authority of Dr. C. Fabre, the author of the well known *Traité Enclyclopédique de Photographie*, the doubtlets will include an angle of more than 100° without spherical aberration."

THE fourth volume of "Bibliotheca Geographica," edited by the Berlin Gesellschaft für Erdkunde, and prepared by Dr. Otto Baschin, has just appeared. It is a classified catalogue of geographical works published during 1895, the works being arranged alphabetically according to authors. The classification adopted is as follows:—A. General geography: (1) bibliography; (2) methods and instruction; (3) general publications; (4) historical geography; (5) mathematical and astronomical geography, cartography; (6) physical geography; (7) biological geography; (8) anthropo-geography; (9) hints for travellers and observers. B. Special geography: (1) voyages and travels in several continents; (2) Europe; (3) Asia; (4) Africa; (5) Australia and New Zealand; (6) Oceania; (7) America; (8) polar regions; (9) oceans and seas. The publisher of the bibliography is W. H. Kuhl, Berlin.

A USEFUL series of graduated arithmetical examples, worked in full by approved methods, makes up a little volume entitled "How to Work Arithmetic," by Mr. Leonard Norman, published at the Rugby Press. The models appear to have been carefully chosen, and should be of assistance in cultivating neatness of style and uniformity of method in large schools.—The use of sketches in teaching the first rules of arithmetic is shown in the "Picturesque Series" of arithmetical problems published by the National Publishing and Supply Association, Ltd., Reading, for Standards I. to III. of elementary schools. The same publishers issue a "Deductive Series of Arithmetical Problems," by Mr. T. Bowen, based on questions asked by inspectors of elementary schools, and with solutions of leading questions worked in full. We have also received from the National Publishing and Supply Association the second edition of "Quantitative Exercises for Beginners in Chemistry," Parts I. and II., by Mr. A. H. Mitchell. The books are adapted to the requirements of students under the Department of Science and Art in quantitative and qualitative analysis.—The third edition of a "Key to Algebraical Factors, and their application to various Processes in Algebra," by Mr. Dorabji H. Vachha, has been published by Messrs. Longmans, Green, and Co.

A SERIES of experiments on the connection between taste and chemical composition has been carried out by Dr. Kahlenberg, and described by him in the *Bulletin* of the University of Wisconsin. Thirteen persons between twenty and thirty years of age—three being women—a lady of sixty, and a gentleman of sixty-three, served as subjects. The subjects were abstainers from alcohol and tobacco, and were kept in ignorance of the composition of the liquids tasted. The results show that for a substance to affect the taste, it must be soluble in water readily diffusible and capable of reacting chemically with the protoplasm of the terminals of the nerves of taste. The taste of solutions is said to correspond to the modern theory of electrolytic dissociation. Thus a sour taste is attributed to hydrogen ions, which may be detected in a 1/800 normal solution, whilst alkaline taste is due to hydroxyl ions. Chlorine ions have a salty taste, and so in a less degree have bromine and iodine ions. The variation of intensity of taste with atomic weight, here indicated, is said to be observed with positive ions.

THE current number of the *Berichte* contains an account of the re-determination of the density of ozone by Prof. Ladenburg. The ozone was prepared as pure as possible by cooling ozonised oxygen in a tube surrounded by liquid air. Of the 22 cc. of liquid thus obtained, nine-tenths were allowed to evaporate in order to remove the liquid oxygen. In this way 2 to 3 cc. of a blue-black opaque liquid were obtained, and with the gas produced by its evaporation two experiments were made, one to determine the density, the other to determine the percentage of ozone. The density was determined by measuring the velocity of effusion, water being used instead of mercury as the trapping

liquid. The amount of ozone in the gas was determined by means of potassium iodide and sodium thiosulphate. The results gave for ozone a density of 1·456 as compared with 1 for oxygen; the theoretical number being, of course, 1·5. The agreement, considering the difficulty of the experiments, is quite satisfactory. In the course of the observations Prof. Ladenburg found that water at ordinary temperatures and pressures does not dissolve more than one-hundredth of its volume of ozone. In attempting to determine the boiling point of liquid ozone it appeared that this point lay at $-125°$ C., but as soon as the boiling commenced the liquid exploded with great violence and reduced the whole apparatus to powder.

THE additions to the Zoological Society's Gardens during the past week include a Serval (*Felis serval*) from Africa, a Black-footed Penguin (*Spheniscus demersus*) from South Africa, presented by Mr. H. S. H. Cavendish; two Black-backed Jackals (*Canis mesomelas*) from South Africa, presented by Lady De Trafford; a South Albemarle Tortoise (*Testudo vicina*) from South Albemarle Island, Galapagos Group, presented by Captain E. S. Tindall; a Ring-tailed Lemur (*Lemur catta*) from Madagascar, a Garnett's Galago (*Galago garnetti*) from East Africa, a —— Kangaroo (*Dorcopsis*, sp. inc.) from New Guinea, an Orange-winged Amazon (*Chrysotis amazonica*) from South America, deposited; two Spur-winged Geese (*Plectropterus gambensis*), two —— Fruit Pigeons (*Phalacrotreron abyssinica*) from West Africa, two Bar-tailed Godwits (*Limosa lapponica*), European, purchased; a Bennett's Wallaby (*Macropus bennetti*), two Squirrel-like Phalangers (*Petaurus sciureus*), born in the Gardens; six Glossy Ibises (*Plegadis falcinellus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE LEONIDS.—During the present week, if we are favoured with fine weather, the Leonid swarm or swarms of meteorites should be very conspicuous, assuming they have not decreased very considerably in number since the year 1865. That a great number of observers will be on the watch for them, there is little doubt, and photography will most probably be extensively used for obtaining records in addition to the naked eye It may be well here to sum up some of the important features which must be noted when observing these moving strangers, and we cannot do better than enumerate those given by Mr. Denning in his interesting article (*Observatory*, 1897) on this great meteor swarm. Thus, the observer should record the exact time of maximum abundance, the number of meteors per minute, the position of the centre of radiation, the area of this radiant if diffuse, and the duration of the shower's chief activity. Further, their relative magnitudes, duration of their visible flights, colours, and the apparent paths of the brighter meteors should be noted. Many other peculiarities which the observer may remark, such as shape of nuclei and apparent diameters of bolides (if there be any), description of curved paths, broken streaks, and duration of streaks with direction of their drift, should be accurately recorded. A convenient form of table for entering such data could be made with the following headlines:—Date, Greenwich Mean Time, Magnitude, Observed path (from R.A., Dec. to R.A., Dec.), Length of trail, and Notes.

It will be of interest to inquire whether the shower is divided into three parts, as Mr. Marsh has suggested. The following is the predicted times for these groups when they will be centrally passed by the earth:—

	Preceding.		Central.		Following.	
		h.		h.		h.
1897 ...	Nov. 13	9·25	Nov. 14	0	Nov. 14	15
1898 ...	,,	15·75	,,	6·5	,,	21·5
1899 .	,,	22·25	,,	13	,,	4

As there will be practically no moon to interfere with the observations this year, every opportunity ought to be taken to obtain a good record. Next year at the same period the moon will be nearly full and visible the whole night, and this will undoubtedly interfere with observations, in spite of the fact that the number of meteors reaches its maximum.

The accompanying chart, which is a reproduction of that published by Prof. W. H. Pickering in his account of the last year's observations at Harvard, shows the position of the radiant point in Leo and the neighbouring constellations.

Further information concerning the probable appearance of this swarm of meteors will be found in the interesting article contributed by our well-known authority on this subject, Mr. Denning, in the present issue.

COMET BROOKS.—This comet is rapidly decreasing its declination and becoming fainter. The following ephemeris is based on the elements of Ristenpart and Muller.

1898.	R.A. (app.)	Decl. (app.)	Br.
	h. m. s.	° '	
Nov. 11	17 53 1	+ 7 39·6	0·6
13	17 57 14	4 50·4	
15	18 0 56	+ 2 16·3	0·5

The comet is still in the constellation of Ophiuchus, and on the 15th will lie in the prolongation of a line joining κ and β Ophiuchi at a distance from β of about one-third of that between these stars.

STARS WITH GREAT VELOCITIES IN THE LINE OF SIGHT.—Prof. W. W. Campbell, who is making spectrographic determinations of stellar motions, has found evidences of large velocities in several of the stars he has examined. η Cephei is one of the stars he mentions (*Astrophysical Journal*, vol. viii. No. 3), and the mean velocity deduced on five different occasions from a discussion of 136 lines in the spectra amounts to $-86·8$ kilometres per second; this when corrected for solar motion reduces to $-74·1$ kilometres per second. The results of Belopolsky for the brighter component of ζ Herculis (*Astr. Nachr.*, vol. 133, p 257–262) have also been corroborated, the corrected velocity amounting to $-53·9$ kilometres per second. It may be remembered that Prof. Keeler found for the planetary nebula G.C. 4373 as a result from six nights of measurement, a velocity of $-64·7$ kilometres per second.

η Pegasi seems to have a very variable velocity, the extreme range observed amounting to 23 kilometres per second. The velocities that Prof. Campbell has obtained up to the present time are:—

	km.		km.
1896 Aug. 27	+ 7·1	1898 Aug. 29	+ 16·5
Sept. 23	+ 5·1	Aug. 30	+ 15·6
1897 July 8	− 6·4	Sept. 4	+ 16·5
Sept. 28	− 2·2		

We are evidently here dealing with a period somewhere about two years in length. Prof. Campbell hopes that if other observers have secured measurements of this star, they will communicate their results to assist him in determining the period.

ON KEEPING MEDUSAE AND OTHER FREE-SWIMMING MARINE ANIMALS ALIVE IN SMALL AQUARIA.

ALTHOUGH many marine animals, more especially those which live between tide-marks, or in shallow water near the shore, can without great difficulty be kept in a healthy state in confinement, this is by no means the case with those invertebrates whose natural habit is to swim freely in the sea, and previous attempts to rear pelagic larvae to the adult stage have only rarely been attended with much success. A method of overcoming some of these difficulties, which should prove of considerable use to marine naturalists, has recently been in use at the Plymouth Laboratory, and is described by Mr. E. T. Browne in the *Journal* of the Marine Biological Association (vol. v. No. 2).

Mr. Browne arrived at the idea of the apparatus as the result of repeated attempts to keep medusae alive in confinement. It was noticed that when recently captured medusae were put into clean sea-water, though they at first swam vigorously about, they invariably became sluggish in the course of a few hours, even if the water were constantly changed, settled to the bottom and finally died. When watching medusae in the sea it was observed that they simply float along with the tide without often pulsating the umbrella. It was therefore thought that if a movement in the water of an aquarium could be obtained, which would keep the medusae constantly floating about independently of their own pulsation, better results might be obtained; and this has proved to be the case. A suitable movement of the water can be conveniently brought about by means of a glass plate made to rise and fall slowly through the water.

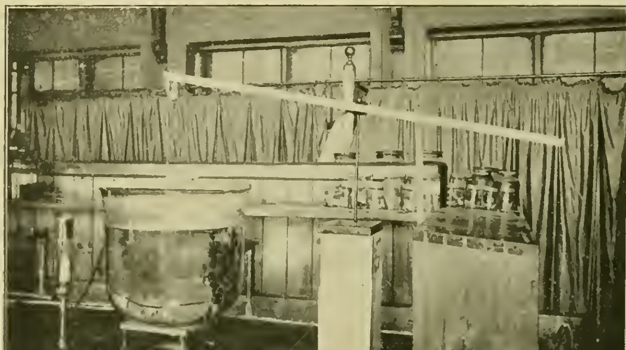


FIG. 1.—Bell-jar with glass plunger.

A motion of this kind can be arranged in many different ways, the apparatus, illustrated in Fig. 1, being the form originally designed by Mr. Browne in conjunction with the Director of the Plymouth Laboratory, which has now been continuously working for a year. The sea water, obtained from the open sea at some distance from shore, is contained in a glass bell-jar of about 10 gallons capacity, provided with a wooden cover made in two halves. A glass plate is suspended in the water by means of a glass rod passing through a hole in its centre, the other end of the rod being attached to one end of a light wooden beam. This beam works on a hinge at the centre, and from its other end a small tin bucket is hung. The bucket is fitted with a self-emptying siphon, and is supplied with a slight stream of water by means of a rubber tube attached to the fresh-water supply. The weights of the bucket and glass plate are so adjusted that the plate moves up and down in the sea-water as the bucket alternately fills and empties. Extra weight is added when required by placing shot in a small bottle hung at one end of the beam. In this way a delicate adjustment can be made, and the plate caused to travel as slowly as is desired. The length of the stroke is regulated by two stops, and a slit in the cover of the bell-jar, through which the glass rod passes, prevents the plate from striking the sides of the jar.

Arrangements have since been made in the laboratory, by which a large number of glass plates, or "plungers" as they have been named, can be worked in a similar way. A modified form of the apparatus, in which the glass plate is replaced by a glass funnel with a small hole in its top, has also been used with advantage. The funnel is fixed so that it is brought out of the water by the upward stroke of the plunger. At each downward stroke it carries with it a funnel-full of air, which escapes by way of the hole, and bubbles through the water.

Amongst the medusae which were successfully kept in the bell-jar were *Phialidium buskianum*, which grew and developed fresh tentacles, *Phialidium cymbaloideum*, which in twenty-five days added five new tentacles and five marginal bulbs, and a species of *Margelis*, which in seventeen days added two new tentacles in each of the four marginal groups, and the oral tentacles twice dichotomously divided. Two medusae of *Cladonema radiatum* were placed in the same bell-jar in the summer of 1897, and in the following spring several colonies of the hydroid of this species appeared. During the present summer (1898) these colonies have freely budded off medusae, several hundreds being seen in the bell-jar at one time.

Crustacean, annelid and molluscan larvae were put into the bell-jar from time to time (together with Copepods), as food for the medusae. Many of the larvae, which escaped capture by the medusae, continued to develop and attained the adult form. Amongst these were *Chaetopterus variopedatus* (the tube of an adult worm from an 1897 larva being about four inches long in June 1898). *Capitella capitata*, *Polynoe* sp., *Nika edulis*, *Portunus* sp., as well as small Gasteropods, Hermit-crabs, and Barnacles. Colonies of hydroids were also found to flourish well when kept in similar aquaria and plentifully supplied with Copepods, which they capture and devour in large numbers. E. J. A.

PHYSICS AT THE AMERICAN ASSOCIATION.

THE Physics Section (Section B) of the American Association was organised with Vice-President Prof. F. P. Whitman in the chair. His vice-presidential address, on colour vision, printed in the issue of *Science* for September 9, was well received, and constitutes a valuable *résumé* of the subject.

The programme of the Section included titles of fifty papers, of which forty were read. Many of these papers were of a very high order, and almost every one of them was creditable and interesting. Brief abstracts of some of them are subjoined.

"A redetermination of the ampere," undertaken, under a grant from the Association, by Prof. G. W. Patterson and Mr. Karl E. Guthe, of Ann Arbor. This work, for which an accuracy of about one part in 8000 is claimed, gives 0·0011192 grammes for the electro-chemical equivalent of silver, and reconciles almost exactly the mechanical equivalent of heat as obtained by electrical methods with Prof. Rowland's corrected

value. An electro-dynamometer of the Weber type was used for measuring current, and the torque due to the current was balanced by the torsion of a phosphor-bronze wire. This wire was standardised by studying its torsional vibrations in a vacuum when carrying a mass of known moment of inertia, and precautions were taken to eliminate the effects of elastic lag.

Experiments bearing upon the "velocity of light in a magnetic field," which were undertaken under a grant from the Association, were reported by Profs. E. V. Morby, H. T. Eddy and D. C. Miller. Their conclusion is that the velocity of light in carbon bisulphide is not altered by one part in a hundred million by a magnetic field of such an intensity as to turn the plane of polarisation through 180° in a path of 65 cm.

"A new gas" was described by Mr. Charles F. Brush. While searching for evidence of the absorption of hydrogen by glass, Mr. Brush discovered that pulverised glass gives off, when heated at a low pressure, a gas whose thermal conductivity at a pressure of a few millionths of an atmosphere is about a hundred times that of hydrogen. This gas was obtained from many other substances, and also by diffusing air through a porous porcelain plug. The kinetic theory indicates that the heat conductivity of a gas is proportional to the reciprocal of the square root of its density. Assuming this relation to hold, this new gas must have a molecular weight of only 0·0002, and a molecular velocity 100 times that of hydrogen.

"On the relative brightness of pigments by oblique vision," by Prof. F. P. Whitman. Prof. Whitman used the flicker photometer, and found that the brightness at the red end of the spectrum decreases as the vision becomes more oblique, while the opposite is true (but to a less extent) at the violet end. The brightness of yellow-green is nearly independent of the angle.

"A geometrical method for investigating diffraction by a circular aperture," by Prof. A. G. Webster. Prof. Webster plots the definite integral involved in this case, and obtains a curve similar to Cornu's spiral, but having cusps like a ratchet.

N. ERNEST DORSEY.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The one hundred and ninety-second meeting of the Oxford University Junior Scientific Club was held on Wednesday, October 26. After private business, Prof. Sollas read a paper on "Funafuti; a study of a Coral Reef." Mr. E. Gurney (New College) then read a paper on "The Birds of the Westman Islands"; in this he also touched upon the characteristic beliefs of the Icelanders, who make their living by catching the birds.

The one hundred and ninety-third meeting of the Club was held on Friday, November 4. After private business, which included the election of twenty-three new members, Dr. Gustav Mann read his paper on "The Origin of Life." Mr. E. S. Goodrich (Merton) briefly explained a model, devised by an American painter, to illustrate the theory of protective coloration in birds, after which the meeting ended. The officers for this term are:—President, Mr. F. P. Nunneley (B.N.C.); Biological Secretary, Mr. E. Gurney (New College); Chemical Secretary, Mr. H. B. Hartley (Balliol); Treasurer, Mr. W. E. Blackall; Editor, Mr. H. E. Stapleton (St. John's); Committee, Mr. F. Soddy (Merton), Mr. A. Angel (Christ Church), Rev. G. D. Allen.

CAMBRIDGE.—At St. John's College, on November 7, the following graduates of the College were elected to fellowships: R. C. Maclaurin, twelfth wrangler 1895, first division of first class Mathematical Tripos, Part II. 1896, bracketed second Smith's Prizeman 1897, Macmahon Law Student 1898; V. H. Blackman, first class Natural Sciences Tripos 1894–95, Hutchinson Research Student 1897, botanical assistant in the British Museum.

At the biennial election of eight members of the Council of the Senate held on November 7, the following were the successful candidates: The Master of Christ's and the Master of Emmanuel, as heads of Colleges; Prof. Ewing, F.R.S., and Prof. Forsyth, F.R.S., as professors; and Dr. Donald MacAlister, Mr. R. T. Wright, Mr. F. Whitting, and Mr. A. W. W. Dale as members of the Senate.

MR. THOMAS REID, of Dundee, has been appointed to the post of Head Teacher of the Engineering Department of the Birmingham Municipal Technical School.

MR. SWALE VINCENT has been elected to the Sharpey Physiological Scholarship (150*l*. per annum) at University College, London. This scholarship carries with it the post of chief assistant in the Physiological Laboratory.—Mr. D. J. Armour has been appointed to the vacant demonstratorship in Anatomy.

AT a meeting of the Council of University College, Liverpool, last week, donations to the amount of 13,000*l*. for the Medical School Building fund from the Right Hon. the Earl of Derby, Mrs. George Holt and Miss Emma Holt, Mr. R. Brocklebank, and Mr. J. Rankine were announced, and a Committee was appointed to prepare plans. The Council hope for further contributions to enable them to put the work in hand without delay.

THE Technical Instruction Committee of the County Borough of Plymouth have passed the following resolution with reference to the Secondary Education Bill introduced into the House of Commons by Colonel Lockwood in June last:—"That this Committee, while generally approving of the introduction of a Bill dealing with this most important subject, is of opinion (1) that it would be prejudicial to the best interests of higher education if secondary were separated from technical education. (2) Also that the multiplication of local authorities for educational purposes is undesirable. (3) That the funds at the disposal of Technical Education Committees are already inadequate for the purposes to which they are assigned, and that it would be impossible to devote any part of the present income to aid secondary education. (4) That the funds which Parliament at present votes for the special encouragement of science and art ought not to be diverted to cover the whole field of secondary education.

THE Calendar for the eighteenth session (1898–9) of the University College, Nottingham, has been received. The College appears to offer every inducement to students to follow systematic courses of study. Day courses of instruction are specially arranged for boys who have just left school and intend to follow the engineering profession in one of its branches. The course of instruction in architecture has been arranged in conjunction with the Nottingham Architectural Society and the School of Art; and the commercial course has been arranged in conjunction with the Nottingham Chamber of Commerce. The associate course in chemistry requires work in the College practically the whole time for three sessions. All chemistry students are strongly advised to continue their studies during a fourth year, so that they may undertake some original investigation and work at the higher branches of the subject. The courses in technical and practical physics, engineering, natural sciences, and agriculture provide for thorough work in these subjects.

IN general (says the *New York Nation*) the Prussian Government, in deciding the salary of a teacher, makes the sum depend to a great extent on the personality and reputation of the individual. A special law regulates the inequality resulting from the difference in the lecture fees received by the various professors—these lecture fees in all the German universities being an income in addition to the regular salary—by decreeing that in Berlin the full professor can receive annually only one-half of these in case they exceed the sum of 4500 marks, and in the provinces 3000; the other half being taken by the State for the benefit of other teachers not blessed with large salaries or fees. In the Würtemberg University of Tübingen, a three-class system of normal salaries is in vogue for the full professors, based on the years of service. The minimum salary is 4030 marks. The assistant professor begins with 2020. A special fund of nearly 150,000 marks is at the disposal of the Government for special salaries in special cases. In the two universities of Baden, Heidelberg and Freiburg, the average salary of the ordinarius is 6955 marks, with additional sums in special cases. The assistant professors draw salaries varying from 1820 to 5220 marks. The Imperial University at Strassburg and the Saxon at Leipzig pay good salaries, but the sums are not mentioned; while the Hessian Institution at Giessen pays its full professors 4300, and its assistants or associates 3250, with an increase until after twenty-five years of service the maximum sums of 6300 and 5250 are reached. In Rostock, the smallest of the German universities, the salaries of the full professors run from 4500 to 5850 marks; the assistant professor begins with 2400. In Jena the lowest sums are paid, the full professors receiving 300 less than is paid even at Rostock.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, October.—The number opens with an account of the fifth summer meeting of the Society, which was held at the Massachusetts Institute of Technology, Boston. As on former occasions, the Society was affiliated with Section A of the American Association for the Advancement of Science. There was a large attendance of members, and at the three sessions which were held twenty-five papers were communicated. Short abstracts of papers by Messrs. Blake, Chessin, Lovett, Baker, Hall, Moore, Conant, Boyd, Stecker, Dickson, Stabler and Martin are given. The journals in which these papers will appear are indicated. Note on the generalisation of Poincaré and Goursat's proof of a theorem of Weierstrass's, by Prof. Osgood, gives an interesting sketch of the theorem, accompanied by full references to original memoirs.—The same author supplies a supplementary note on a single-valued function with a natural boundary, whose inverse is also single-valued. This is supplementary to a paper in the June *Bulletin*, and states the writer's indebtedness for a simple proof of his principal theorem to Prof. Hurwitz.—Prof. Chessin contributes a note on the periodic developments of the equation of the centre and of the logarithms of the radius vector.—The theorems of oscillation of Sturm and Klein is a third paper on the subject, by Prof. Bôcher. Its object is to extend the results previously established to some cases in which the coefficients of the differential equation (discussed in the preceding papers) are no longer continuous throughout the intervals considered in the investigation. The article occupies pp. 22–43. There are numerous vacation notes, and a long list of new publications. It is worth noticing that the Society has appointed a Committee to consider the question of securing improved facilities for the publication of original mathematical papers (in the States). On p. 48 it should be Prof. Price has resigned the Sadleian Professorship (not Sadlerian, which is a Cambridge professorship).

Symons's Monthly Meteorological Magazine, October.—Heat and drought in September 1898. Reference to the regular table of rainfall and temperature at fifty stations shows that the month was remarkably dry over the whole of England and Wales. At twenty-one of the stations the rainfall was less than half the average, and nine of them show a deficiency of 75 per cent. The deficiency is most marked in the east and north-east of England, where the falls were generally about a quarter of an inch. September 1895 was very dry; September 1898 yielded a larger number of both absolute and partial droughts, but a smaller number of stations with less than half the average fall. To illustrate the distribution of temperature during the month, a table of shade maxima at twenty-five stations is given, for September 3–9 and 14–17. On all these days there are numerous entries above 80°, while on the 8th there are eleven records of 90° and upwards. Although the absolute maximum at Camden Square in 1898 (91°·2) is unprecedented, and no other September during the last forty years has had so many days above 85°, yet in 1865 there were two more days above 80°.—Results of meteorological observations for September at Camden Square for forty years, 1858–97. The average rainfall is 2·39 inches; the year 1898 had only ·33 inch, being the smallest September fall since 1858. The mean temperature in September for the forty years is 57°·7. The mean for 1898 was 61°·6, being an excess of 3°·9 from the normal; there is only one instance of a higher mean, viz. 63°·6, in the year 1865.

Wiedemann's Annalen der Physik und Chemie, No. 9.—Electric currents produced by Röntgen rays, by A. Winkelmann. Like Perrin, the author succeeded in obtaining differences of potential between two different metals under the influence of x-rays, and also a steady current of about 6×10^{-9} amperes in a circuit containing two such metals. He calculates an inferior limit for the ratio of the number of ionised molecules of air traversed by x-rays to the total number of molecules, and finds it to be $4 \cdot 6 \times 10^{-13}$.—Magnetic hysteresis, by F. Niethammer. The loss of energy in alternate-current hysteresis is greater than in magnetostatic hysteresis. It is nearly the same for sinusoidal and for flat curves, but less for pointed curves, for the same maximum induction.—Reflection of kathode rays, by H. Starke. The rays enter a spherical vessel from a side tube, and are reflected by a metallic mirror mounted in the centre and movable by a handle outside. After reflection, the rays are caught in another side tube containing an electrode leading to a galvanometer. The galvanometer shows the same deflection within wide limits of the orientation of the mirror. Hence the deflection is diffuse, the particles being so small that even a highly polished surface is rough to them. The current is greatly increased by insulating the mirror instead of connecting it to earth. The denser metals have the greater reflective power.—Disintegration of incandescent platinum and palladium wires, by W. Stewart. The disintegration of wires rendered incandescent by an electric current gradually decreases as time goes on, but is unaffected by the presence or absence of moisture in the air. When the air is exhausted, the disintegration of platinum diminishes, while that of palladium increases. Platinum is not disintegrated in hydrogen.—Causes of the changes of resistance discovered by Branly, by D. van Gulik. Branly's view that the conductivity of powders acquired under the influence of electric radiation is due to a modification of the dielectric surrounding them is untenable, as experiments with minute terminals under the microscope prove the correctness of Lodge's view that the conductivity is due to mechanical contact.—Observations concerning coherers, by E. Dorn. To be effective, metallic powders should be somewhat easily oxidised, and should be exposed to the air so as to acquire a coating of oxide. Good results are obtained with iron and copper, but not with the noble metals.—A supposed unknown constituent of the atmosphere, by O. Neovius. The author finds a number of lines which are identical in the nitrogen spectrum and the blue argon spectrum, and may be due to an unknown gas occurring as an impurity in both. These lines show only a single coincidence with those of crypton, at 4736.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, October 28.—Mr. Shelford Bidwell, F.R.S., President, in the chair.—A paper was read by Mr. W. R. Pidgeon on an influence machine. The machine, which was exhibited, consists of a pair of glass discs, rotating in opposite directions upon a spindle. They are partially covered on one face with narrow radial sectors of tin-foil, each provided with a small brass knob. This face of the disc, including its sectors, is then coated with insulating wax, leaving only the knobs projecting through the wax. Two earthing-brushes pass through two insulated fixed inductors, and support them. The inductors are kept charged by exploring-points connected to each, and placed so as to collect electricity from the revolving discs. By means of brushes, the sectors on each of the discs are successively earthed at the moment they pass the fixed inductors, *i.e.* at the moment that their capacity is a maximum; and they are made to deliver up their charge to the main collecting brushes at the moment when they are electrically farthest from the inductors, *i.e.* when their capacity is a minimum. Hence, if there is no loss of electricity in the process, the potential at the collecting brushes is proportionately high. Each sector of a particular disc, as it moves away from its inductor with rising potential, induces a corresponding potential on the sectors opposed to it on the second disc; this action is cumulative. The thick coating of wax restricts leakage to the small area of the contact knobs, so that surface effects of dirt and moisture are minimised. Captain J. H. Thomson, R.A., said that, apart from its electrical merits, the machine possessed advantages in mechanical construction. He thought there was still room for improvement in this respect. The counter-shaft should be done away with, and ball-bearings should be introduced. The inductor was a distinct improvement; he thought the efficiency might be increased by adding other inductors. Platinum-iridium was the best material for brushes of such machines. Prof. Ayrton asked what efficiency was obtained with modern influence machines, in general. Captain Thomson had found that when running a machine by a motor, about 80 per cent. of the power was wasted in mechanical friction; of the remaining 20 per cent. a great deal was lost as electrical leakage. Prof. S. P. Thompson thought it had been pointed out by Mr. Wimshurst that influence machines did not work well unless there were at least two thicknesses of glass between the inducing and induced conductors. That was why Mr. Wimshurst put his sectors on the outer faces of the glass discs. Mr. Pidgeon had departed from this. The advantage of the narrow spacing of the sectors was not very apparent. Mr. Wimshurst (abstract of communication): Waxing the discs reduces leakage, and increases the output; the wax-coating virtually doubles the number of plates. Inductors contribute a further increase to the output. In 1883 Mr. Wimshurst tried thick coatings of shellac, and also, duplicating the glass, with in

some cases sectors upon the second glass to increase the capacity. The output was increased, but the construction lost simplicity. The indifference of Mr. Pidgeon's machine to dirt and dust was a most valuable result. Mr. Pidgeon, in reply, showed a set of secondary inductors such as Captain Thomson had just proposed. They improved the output by about 15 per cent., but they were troublesome to keep in order, for they increased the tendency to "reverse."—Dr. S. P. Thompson then repeated an experiment discovered by Prof. Righi, on a magneto-optic phenomenon. It was originally described in *Roma, R. Accad. Lincei, Atti* 7, *ser.* 5, 1898. A substance absorptive of light is submitted to a powerful magnetic field between the pole-pieces of an electro-magnet. The pole-pieces are drilled so that a beam of light from an arc-lamp can traverse the gap *along* the magnetic lines. A polarising prism is placed between the arc-lamp and the electro-magnet. After having passed through the magnetising apparatus, the beam thus polarised is examined by an analyser. The analyser must be turned to "extinction" before the magnetising current is turned on. If this is done, brightness is restored at the analyser as soon as the magnetic field is established. The substance absorbing the light in the gap may be nitric oxide fumes, or an ordinary spirit-lamp sodium flame. The second effect to be noticed is that when the emergent beam is examined, there is a splitting of the lines. Righi explains this by supposing that when light of frequency n is brought into a magnetic field and passed *along* the lines of the field, it is split up into two sets of circular waves, a right-handed and a left-handed set, one of which sets is accelerated and the other retarded. There are now two frequencies n_1, n_2, one a little higher and the other a little lower than n. But since the analyser is adjusted to extinguish n, there is brightness for n_1, n_2. Normally, nitric oxide absorbs green, and red is observed; but when the magnetic field is set up, blue-green light is seen at the analyser; for there are now two different kinds of light being absorbed, one of higher and one of lower frequency than the normal, and what is observed is the complementary spectrum. Again, if a tube of sodium is warmed to a point far short of that which would cause it to emit visible rays, and the vapour is passed into the magnet gap, at the moment when the magnetic field is set up the D line becomes visible in the observing spectroscope, *i.e.* the emission spectrum is obtained of a substance which is not actually emitting light. Mr. Blakesley said that no doubt the analyser was used at the position of extinction for convenience merely. In other positions the eye would be overwhelmed with light.—Mr. Albert Campbell then read a paper on the magnetic fluxes in meters and other electrical instruments. He has recently undertaken the measurement of the magnetic fluxes and fields in certain instruments, to determine the order of magnitude of the flux density. In other cases the *total* flux is measured; and in the tests on meters, the power lost in the various parts of the instruments is determined. For the measurement of B, the ordinary ballistic-galvanometer method is employed, with an exploring-coil. But, for alternating fluxes, two special methods are adopted, in the first of which the exploring-coil is in series with a heating-coil associated with a thermopile; in the second, a telephone is connected in series with the search-coil and a potentiometer resistance strip. A constant current is sent through the strip from the main alternate-current circuit supplying the meter or other apparatus; the telephone and search-coil therefore forms a shunt to that circuit at the strip. The search-coil is put into position in the field to be tested, and the strip is then adjusted to give silence in the telephone. All these methods are described in detail in the paper, and very important deductions are made, especially as regards the influence of the earth's field on instruments generally assumed to be independent of the earth's H. In a few cases, diagrams are given of the fluxes in magnets, showing exactly what proportion of the total flux is effective at the gap. Dr. S. P. Thompson suggested that as the paper was of great significance to all who were interested in the design of electric meters and other measuring instruments involving a knowledge of magnetic fluxes and their variation, an opportunity should be given for a full discussion.—The President proposed votes of thanks, and adjourned the discussion of Mr. Campbell's paper to the next meeting on November 11.

PARIS.

Academy of Sciences, October 31.—M. Wolf in the chair.—Remarks on rotatory magnetic polarisation, and anomalous dispersion, by M. Henri Becquerel. Remarks concerning the experiments of MM. Macaluso and Corbino. A bundle of polarised white light traverses the pierced armature of a strong electro-magnet, and is analysed by a spectroscope after passing through a sodium flame placed in the field. The absorption bands under these conditions are seen when the current is passing to be bordered by a series of bright dark bands, which are displaced on rotating the analysing nicol.—Peculiarities relating to the innervation and general physiological properties of the nerves of the *sphincter ani*, by MM. S. Arloing and Edouard Chantre.—On divergent series and functions defined by a Taylor's series, by M. Le Roy.—A property of a first integral of the equations of dynamics of two variables with homogeneous potential, by MM. W. Ebert and J. Perchot.—On the ratio of the two specific heats of gases, and its variation with temperature, by M. A. Leduc. From the formulae developed in previous papers the author concludes that γ, the value for the ratio of the two specific heats of air, varies slightly with the temperature, the ratio γ_0/γ_{100} being about 1·0006. The variation is much more rapid with carbon dioxide, for which γ_0/γ_{100} is 1·028. From the experiments of Wüllner, the values of γ_0 are calculated for several gases.—New apparatus for the measurement of luminosity, by M. Onimus. The apparatus described permits of the comparison of the light intensities of two days, or of one country with another. The method adopted is a photographic one, the tint taken up by a standard sensitised paper under fixed conditions being compared with a tintometer prepared by superposing pellicles of slightly tinted collodion; the deepest tint, No. 24, being composed of 24 pellicles of collodion. The apparatus is extremely simple, and can be used without any special knowledge of photography, the ferro-prussiate paper used requiring only washing with water after exposure.—Action of phenylhydrazine upon chloranilic acid, by M. A. Descomps. The result of the reaction is a well-crystallised substance of the composition $C_6Cl_2O_2$,

$$(OH.C_6H_5.NH.NH_2)_2,$$

analogous to the body obtained by MM. Baeyer and Kochendoerfer by the interaction of phenylhydrazine and phloroglucinol.—On the presence of a soluble proteo-hydrolytic ferment in mushrooms, by MM. Em. Bourquelot and H. Hérissey. A solution of the ferment was obtained by triturating the fungi *Amanita muscaria* and *Clitocybe nebularis* with sand and chloroform water, and this was allowed to act upon milk, specially freed from fat. The action of the ferment is analogous to, if not identical with, trypsine.—On the influence of temperature on the determination of sex, by M. Marin Molliard. Experiments carried out on the development of *Mercurialis annua* at varying temperatures showed that heat favours, in this case, the production of female individuals.—Characters of the latent life of bulbs and tubers, by M. Leclerc du Sablon.—The limurites in contact with the granitic rocks of the Hautes-Pyrenees, by M. A. Lacroix. These rocks are characterised by the existence of a violet axinite, which sometimes forms nearly the whole rock mass, but is more often accompanied by pyroxene, quartz, albite, and other minerals.—Experimental study of subterranean sedimentation, by M. Stanislas Meunier.—On the secondary formations of the south of the Montagne-Noire, by M. René Nicklès.—The absorption of mercury by leucocytes, by M. Henri Stassano. The leucocytes of the blood of dogs, into whose veins minute quantities of mercury perchloride had been injected, showed, after careful separation, the presence of a perceptible amount of mercury. The experiments show clearly that the leucocytes are the exclusive agents of transportation and absorption of mercurial compounds in the circulation.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part iii. for 1898, contains the following memoirs communicated to the Society:—

May 14.—G. Kümmell: The climatological data of Göttingen for the years 1887–1896.

March 19.—E. Wiechert: Experimental researches on the velocity and magnetic deviability of the kathode-rays.

July 9.—W. Voigt: On the light which penetrates the second medium in so-called "total" reflexion.—A Hurwitz: On the composition of quadratic forms of any number of variables.—E. Timerding: The Reyeian geometry of the *continua* of projective ground-forms.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 10.

MATHEMATICAL SOCIETY, at 8.—Some Secondary Needs and Opportunities of English Mathematicians: Presidential Address.—The Structure of certain Linear Groups with Quadratic Invariants: Dr. L. E. Dickson.—Multiform Solutions of certain Differential Equations of Physical Mathematics and their Applications: H. S. Carslaw.—A Discovery in the Theory of Compound Partitions: Major Macmahon, R.A., F.R.S.—On Groups of Order $p^a q^\beta$: Prof. Burnside, F.R.S.—On the Null Spaces of a One System and its Associated Complexes: W. H. Young.—On the Functions Y and Z which satisfy the Identity

$$4(x^p - 1)/(x - 1) = Y^2 \pm pZ^2:$$

Prof. L. J. Rogers.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rotatory Converters: Prof Silvanus P. Thompson, F.R.S.

FRIDAY, NOVEMBER 11.

ROYAL ASTRONOMICAL SOCIETY, at 8.—The Development of $\left[\frac{r}{a}\right]^n$ sin cos mw: R T. A. Innes—Remarks on Dr. Gill's Paper in the *Monthly Notices* for June 1898: A. A. Rambaut.—Note on Mr Pogson's Manuscripts relating to his proposed Atlas of Variable Stars: Rev. J. G. Hagen.—(1) On the South Temperate Current of Jupiter; (2) Nomenclature of the Chief Surface Currents of Jupiter: A. Stanley Williams.—(1) On a New Instrument for Measuring Astrophotographic Plates; (2) On a Method of obtaining Perfectly Circular Dots unaffected by Phase, and their Employment for Determining the Pivot Errors of the Cape Transit Circle: David Gill.—On some Photographs of the Moon, Comets, Meteors, and the Milky Way, and on the Exterior Nebulosities of the Pleiades: E. E. Barnard.—(1) Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1897, deduced from Photographs taken at Greenwich, at Dehra Dûn (India), and in Mauritius; (2) Observations of Planet 433 (1898 DQ) with the 30-inch Reflector of the Thompson Equatorial: Royal Observatory, Greenwich.——*Papers promised*: Brief Account of the New Photographic Telescope at Cambridge Observatory: Sir R. S. Ball.—(1) Approximate Ephemeris of the Leonids; (2) Forecast of the Time of the Leonid Shower of 1898; (3) On the Presence of Helium in the Earth's Atmosphere: G. Johnstone Stoney.

PHYSICAL SOCIETY, at 5.—Discussion on Mr. A. Campbell's Paper on the Magnetic Fluxes in Meters and other Electrical Instruments, to be opened by Prof. W. E. Ayrton, F.R.S.—On the Propagation of Damped Electrical Oscillations along Parallel Wires: Prof. W. B. Morton.—On the Properties of Liquid Mixtures: R. A. Lehfeldt.

MALACOLOGICAL SOCIETY, at 8.—A Revision of the Pliocene Non-Marine Mollusca of England: A. S. Kennard and B. B. Woodward.—Description of Two New Species of *Trochidae* from the Commander Islands: Edgar A. Smith.—Description of a New Species of *Tridacna*: G. B. Sowerby.—On some Supposed New Species of Land Mollusca from the Moluccas: H Fulton.

MONDAY, NOVEMBER 14.

IMPERIAL INSTITUTE, at 8.30.—Trinidad, with Special Reference to the Recent Hurricane: H. Caracciolo.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A British Antarctic Expedition: Addresses by the President and others.

TUESDAY, NOVEMBER 15.

ZOOLOGICAL SOCIETY, at 8.30.—A Revision of the Moths of the Subfamily *Pyraustinae* and Family *Pyralidae*, Part I.: Sir George Hampson, Bart.—List of Mammals obtained by Mr. R. McD. Hawker during a Recent Expedition to Somaliland: W. E. de Winton.—On Mammals collected by Mr. J. D. La Touche at Kuatun, N.W. Fokien: Oldfield Thomas.—Revision of the Genera and Species of Fishes of the Family *Mormyridae*: Mr. Boulenger.

MINERALOGICAL SOCIETY, at 8.—Anniversary Meeting.—Election of Officers and Council.—Plagionite, Heteromorphite, and Semseyite as Members of a Natural Group of Minerals: L. J. Spencer; with Chemical Analyses by G. T. Prior.—Petrographical Notes on Rock Specimens collected during the Ross Antarctic Expedition of 1839–43: G. T. Prior.—Mineralogical Notes from the Oxford University Laboratory (Communicated): Prof Miers, F.R.S.—Note on the Occurrence of Riebeckite in Trachytic Rocks from Abyssinia: G. T. Prior.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Electrical Transmission of Power in Mining: William Beedie Esson.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—On Rapid Dry Plates for Process Work: Combined Screen and Colour Negatives for Three-Colour Printing: A. A. K. Tallent.—On the Melting and Setting Points of Gelatine Solutions, and their Modification: R. Child Bayley.

WEDNESDAY, NOVEMBER 16.

SOCIETY OF ARTS, at 8.—Opening Address by Sir J. Wolfe Barry, K.C.B., F.R.S., on the Internal Traffic of London.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Report on Experiments upon the Exposure of Anemometers at Different Elevations: The Wind Force Committee.—Comparison of Estimated Wind Force with that given by Anemometers: Captain D. Wilson-Barker.—The Tornado at Camberwell, October 29, 1898: William Marriott.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Thum's Slides of Diatoms in High Refractive Media.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 17.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—On some Spiders from Chili and Peru: F. O. Pickard Cambridge.—The Botanical Results of a Journey into the Interior of Western Australia: Spencer Moore.

CHEMICAL SOCIETY, at 8.—Preparation of Hyponitrite from Nitrite through Oxyamidosulphonate: Dr. E. Divers, F.R.S., and T. Haga.—(1) Absorption of Nitric Oxide in Gas Analysis; (2) Interaction of Nitric Oxide with Silver Nitrate; (3) Preparation of Pure Alkali Nitrites; (4) The Reduction of an Alkali Nitrite by an Alkali Metal; (5) Hyponitrites: their Preparation by Sodium or Potassium and Properties: Dr. E. Divers, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Story of the Cotton Plant: F. Wilkinson (Newnes).—Primer of Geometry: J. Sutherland (Longmans).—Chemistry in Daily Life: Dr. Lassar-Cohn, translated by M. M. P. Muir, 2nd edition (Grevel).—Das Leitvermögen der Elektrolyte: Dr. F. Kohlrausch and Dr. L. Holborn (Leipzig, Teubner).—Comparative Photographic Spectra of Stars to the $3\frac{1}{2}$ Magnitude: F. McClean (Dulau).—Spectra of Southern Stars: F. McClean (Stanford).—Monographia Roccelleorum: O. V. Darbishire (Stuttgart, Nägele).—Observations and Researches made at the Hongkong Observatory in the Year 1897: W. Doberck (Hongkong).—Railway "Block" Signalling: J. Pigg (Biggs).—Chemistry for Schools: C. H. Gill, 10th edition, revised and enlarged by Dr. D. H. Jackson (Stanford).—First Lessons in Modern Geology: A. H Green (Oxford, Clarendon Press).—A Middle Algebra: W Briggs and Prof. Bryan (Clive).—Elemente der Mineralogie: Naumann and Zirkel, ii. Hälfte, Specieller Theil (Leipzig, Engelmann).—Electrical Engineering: W. Slingo and A. Brooker, new edition (Longmans).—Conspectul Florei Romaniei: Dr. D. Grecescu (Berlin, Friedländer).—Four-footed Americans and their Kin: M. O. Wright (Macmillan).—An Introductory Logic: Prof. J. E. Creighton (Macmillan).—Differential and Integral Calculus: P. A. Lambert (Macmillan).—Der Ursprung der Kultur: L. Frobenius. Erster Band: Der Ursprung der Afrikanischen Kulturen (Berlin, Borntraeger).

PAMPHLETS.—A Plan and Plea for National Medicine; E. L. Garbett (Reeves).—The Transition of North Carolina from Colony to Commonwealth: Prof. E. W. Sikes (Baltimore).—Petrographical and Geological Investigations of certain Transvaal Norites, Gabbros, and Pyroxenites, and other South African Rocks: J. A. L. Henderson (Dulau).—Mines and Quarries: Reports of Le Neve Foster for the North Wales, &c., District (No. 9) for the Year 1897 (Darling).

SERIALS.—Fortnightly Review, November (Chapman).—National Review, November (Arnold).—Madras Government Museum, Bulletin, Vol. 2, No. 2, Anthropology (Madras).—Natural Science, November (Dent).—Middlesex Hospital Journal, October (London).—Zeitschrift für Physikalische Chemie, xxvii. Band, 2 Heft (Leipzig, Engelmann).—Geographical Journal, November (Stanford).—Knowledge, November (Witherby).—Journal of the Sanitary Institute, October (Stanford).—Science Progress, October (Scientific Press).—Terrestrial Magnetism, September (Cincinnati).—Journal of Botany, November (West).—Botanische Jahrbücher, Sechsundzwanzigster Band, 2 Heft (Leipzig).—Zeitschrift für Wissenschaftliche Zoologie, lxiv. Band, 4 Heft (Leipzig).

CONTENTS.

THURSDAY, NOVEMBER 17, 1898.

THE ANATOMY OF BIRDS.

The Structure and Classification of Birds. By F. E. Beddard. Pp. xx + 548, illustrated. (London : Longmans, Green, and Co., 1898.)

READERS of the *Zoological Society's Proceedings* may not improbably have been struck by the comparatively small number of papers communicated to the last few issues by the prosector. The present handsomely got-up volume shows, however, that Mr. Beddard has been fully occupied in anatomical investigations, and he is to be congratulated in presenting the results of his labours in such an attractive and well arranged form.

As stated in the preface, the work is not solely based on his own researches, since his two immediate predecessors in office devoted a large amount of time and labour to the study of the anatomy and affinities of birds. Portions of such work have been from time to time published in separate papers ; but a large amount of MS. was left by Prof. Garrod, of which Mr. Beddard has availed himself. It is thus highly satisfactory to have in a combined and handy form the leading results of the united work of three such distinguished bird anatomists as the author and his two predecessors.

Although works on the external characters and classification of birds abound, treatises in English on avian anatomy and morphology are rare ; and the present work therefore fills a distinct gap—and fills it well. Commencing with a purposely brief sketch of the general principles of bird structure, Mr. Beddard devotes the greater part of his volume to the characteristic structural characters of the different groups of birds. To a considerable extent this ground has indeed been covered by Dr. Gadow, but the author has treated the subject in greater detail, and has recorded a number of new facts, many of which are highly important.

The general anatomy of the class is treated in a manner which, while ministering to the wants of the advanced student, can scarcely fail to interest those lovers of birds who desire to know something more than the mere arrangement and colours of the feathers. And especial attention may be directed to the section devoted to the gradually increasing complexity of the folds of the intestine as we pass to the more specialised forms. Here, as elsewhere, an admirable series of illustrations display in the clearest form the various types of structure discussed.

In the osteological section of general anatomy the paragraph devoted to the hyoid (p. 136), if not absolutely incorrect, is certainly very far from clear, and, moreover, does not agree with the explanatory figure on the opposite page. Again, on p. 140 we meet, in a quotation from Dr. Coues, with the word "fadge," which, if correctly printed, certainly stands in need of explanation to ordinary readers. And, although there is no difficulty about their meaning, we must venture to protest against the use of such terms as "schizorhiny" and "holorhiny," in place of schizorhinism and holorhinism.

Turning to the classificatory portion of the subject, the table of contents looks as though the author was starting a missing word competition—without offering a prize to the solver! At the commencement of the table (p. x.) we find the term *Ornithurae* printed in the same vertical line as a series of other names apparently intended to indicate groups of inferior rank ; and at the end, also in the same line, the term *Saururae*, evidently the equivalent in rank to the first. Such a small error in alignment might well be passed over without notice. But immediately below *Ornithurae* occurs the term *Anomologonatae*, followed in the same vertical line by *Passeres* and *Pici*. And on looking down the table we fail to find any group corresponding in rank to this *Anomologonatae*, so that there is not the faintest clue to the number of orders it is intended to embrace. On turning to the page (167) where the *Anomologonatae* are described we likewise fail to discover its antithesis. Neither does the index help us, since terms of higher rank than genera are excluded therefrom ; this being, in our opinion, a decidedly objectionable plan. Almost by chance, we at length succeeded in stumbling on the missing word—to wit, *Homalogonatae*—on p. 165 ; but even when thus found, the reader is apparently left totally in the dark as to the number of ordinal groups thus brigaded together. Another glaring error in the "Contents" cannot be overlooked. By the position and large type in which the item "Reproduction[tive] and Renal Organs" is printed, it is made to include such subjects as myology, osteology, &c.!

In printing the names of ordinal and higher groups in block type, the author is perhaps well advised. But personally we decidedly object to the names of writers being similarly distinguished ; the important point to which attention should be directed being the fact recorded, and not the more or less distinguished individual by whom it was discovered. And here it may be mentioned that authors' names are not always correctly spelt, a superfluous *e* being generally, although not always, intercalated in that of one well-known avian osteologist. Moreover, if we mistake not, full justice has not been done to the labours of the same writer, who contributed the last paper bearing on one of the subjects on which the late Mr. Wray is alone quoted as the latest authority.

Neither is the work quite free from errors of expression. For example, in treating of the *Limicolae* (pp. 326 and 327), we meet with the following passage :—"The type family is that of the *Charadriidae*, which contains the largest number of genera ; the remaining families are not separated from it by very numerous points of difference, and the group as a whole is very near to the gulls, which I only divide as a family." That is to say, a group is allied to a portion of itself!

As regards the serial arrangement of the various orders (of which a large number are adopted), comparatively few remarks will suffice. Some surprise will be experienced in finding the *Accipitres* placed near the end of the series between the extinct *Ichthyornithes* and the modern tinamous, to neither of which they have any affinity. And when we find it stated (p. 469) that the *Ichthyornithes* themselves are probably allied to the stork and plover tribe, it seems strange to find them located between the *Anseres* and the *Accipitres*. Again,

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when the author himself admits that the nearest relations of the tinamous are the *Struthiones* (*Ratitae*) on the one hand, and the game birds on the other, it seems decidedly strange that the latter group is not placed in juxtaposition.

The mention of *Struthiones* reminds us that the student perusing the table of contents would gain the idea that the group includes only the two extinct families *Aepyornithidae* and *Dinornithidae*, since these two are alone mentioned. On turning to the corresponding text, it will be found that only these two families are referred to by name, from which we draw the inference that Mr. Beddard has allowed his table of contents to be compiled for him. Of course either all or none of the families should have been given.

Reverting to the orders, it may be noted that Mr. Beddard includes the flamingoes (omitted from the table of contents !) in the *Herodiones*, refusing to admit that they have any relationship with the *Anseres*. In this he is fully supported by osteology. In placing the extinct *Hesporornis* next the divers, we are glad to see that he rejects the recently revived heresy of the Ratite affinities of the former. But whether the penguins are well placed between the *Hesperornithes* and the *Steganopodes* may perhaps be open to question. On the other hand, the location of the owls next the parrots, in association with various groups of the old "Picariae," will probably meet with general approbation.

As regards the ancestry of birds, the author, while refusing to reject a dinosaurian affinity, is inclined to admit some kind of relationship with pterodactyles. It is, however, somewhat difficult to understand such a double consanguinity.

In conclusion, attention may be drawn to the remarkable difference displayed by the caeca of different genera of tinamous, as exemplified by the figures on p. 488. The mere record of such differences is, it is true, an addition to knowledge ; but, as has been remarked by Prof. Newton, what we really want to know is the physiological reason for such variations. And until this is ascertained, we are merely wandering aimlessly in the dark.

As an excellent compendium of the present state of our knowledge of bird anatomy, Mr. Beddard's work may be heartily commended. The blemishes by which the present issue is disfigured may, we hope, be removed in a second edition, which ought to be called for at no very distant date.

R. L.

EGYPTIAN MUMMIES IN THE BRITISH MUSEUM.

British Museum. A Guide to the First and Second Egyptian Rooms. Mummies, Mummy-Cases, and other Objects connected with the Funeral Rites of the Ancient Egyptians. By E. A. Wallis Budge, M.A., Litt.D., D.Lit., F.S.A., Keeper of the Egyptian and Assyrian Antiquities. Pp. viii + 92, with 25 plates. (Printed by order of the Trustees, 1898.)

THE national collection of Egyptian antiquities in the British Museum is, speaking generally, the most complete in Europe. Other collections may perhaps excel it in certain classes of antiquities as, for instance, the Louvre in its unique series of Apis stelae discovered by Mariette, or the Berlin Museum in its specimens of sculpture from tombs of the Early Empire. But the collection in the British Museum is the finest representative collection, comprising as it does typical examples of antiquities of most classes and periods. This is nowhere truer than in the two galleries which are set apart for objects connected with the funeral rites of the ancient Egyptians. During the last twenty-five years, and more particularly during the last ten years, the Trustees of the Museum have been steadily increasing their already fine collection of mummies and mummy-cases, so that they are now in possession of a remarkable series ranging over most of the historical period of Egyptian history, from about B.C. 3600 to A.D. 400. Moreover, the work of arranging and cataloguing the collection has kept pace with that of acquisition. During the past eighteen months any visitor to the Egyptian Department might have noticed a small army of workmen setting in place new wall-cases and standard-cases, remounting the mummies and coffins, and, under the direction of the Keeper, arranging them in chronological order. This work has now been brought to an end with the issue of the "Guide to the First and Second Egyptian Rooms" that has just been published by the Trustees.

To give some idea of the scope of the Guide, it may here be stated that the collection exhibited in these two rooms consists of forty-four mummies and eighty coffins and cartonnage-cases, including typical examples of all periods ; wooden figures of *Ptah-Seker-Ȧusȧr*, the triune Egyptian god of the resurrection ; shabti figures of stone, wood, and glazed porcelain, which were placed in the tombs to do the work of the deceased in the nether world ; and sets of Canopic jars, in which the principal intestines of the deceased were placed, after being removed from the body before the process of embalming. The Guide describes the contents of the galleries, case by case, and as these are arranged in chronological order we can examine and compare at leisure the changing fashions and methods of embalming which were practised by the Egyptians during the long course of their history.

In his Introduction, for the benefit of students who are not Egyptologists, Dr. Budge gives a sketch of the principal features of the Egyptian religion, emphasising their belief in a supreme being, *neter*, apart from the *neteru*, the personifications of special powers or natural phenomena. He then sketches the principal views held by the Egyptians with regard to the nature of the gods and the origin of the universe, and this is followed by a descriptive list of the gods mentioned in the "Book of the Dead," and whose names are frequently met with in the main body of the Guide. Passing to the Egyptian idea of a future life, Dr. Budge enumerates the nine parts which were believed to form a man's personality ; the ritual and ceremonies are next referred to which accompanied the deposit of the dead body in the tomb, and which were gradually grouped together by the Egyptian priests into a number of chapters now generally known as the "Book of the Dead." Finally an account of the different methods of mummifying is given, and the tomb is described with its funereal furniture.

Among the mummies belonging to the early period e two of peculiar interest, which we believe are recent ditions to the collection. These are the skeletons of o Egyptian officials, Khati and Ḥeni, which are exoited in the First Egyptian Room in cases E and F ove the rectangular wooden coffins in which they were und. These two skeletons date from about 2600 B.C., d represent a peculiar method of burial, unlike the ual Egyptian custom of mummifying the body. In e case of Khati and Ḥeni the flesh was removed from e bones before burial by means of muriate of soda or tron, and the bones were then treated with bitumen, hich has tinted them a light yellow; they were then apped in linen, a layer of which may be seen in case under Khati's skeleton. Khati's skull is peculiarly eresting on account of the two indentations in the rietal bones; these, Dr. Budge remarks, "must have en made artificially in early childhood because the rface of the bones is not broken." Ḥeni's bones have en articulated, and the skeleton is about 5 feet 6 inches ng; it is a very fine specimen of this method of ummifying as carried on under the eleventh dynasty. is method of mummifying the dead, by treating the nes with bitumen after removing the flesh, goes back any thousands of years, and was probably the earliest ethod of preserving their dead employed by the inbitants of Egypt; for many of the skeletons from ehistoric sites that have been recently found by M. de organ have been treated with bitumen in a similar anner.

Turning to the later portion of the collection, among the ost noteworthy exhibits are three painted cartonnageses of a Graeco-Roman official (Plate xxiii.) and his o wives, one of whom is figured on Plate xxiv. These e fancy are also recent additions to the collection, and e probably the best examples of their kind in Europe. he modelling is good, so that the cases are remarkably e-like and give a good idea of the dress worn at the riod, about 200 A.D.

We have not done more than give a passing reference three or four out of this unique series of mummies d mummy-cases. Beginning in the First Egyptian oom with the mummy-case of Mycerinus, the builder of e fourth pyramid at Gizeh in the fourth millenium B.C., d ending with the wooden coffin of the Greek or Roman dy, who lies with her three children at the end of the econd Egyptian Room, we can trace upon the mummies d their cases the religious beliefs of the ancient gyptians as they developed through a period of some ur thousand years. To the student of religions a comarative study of this nature presents considerable atactions, and he will welcome Dr. Budge's guide, which upplies him with concise though detailed information on very exhibit in the two galleries. The Trustees, with a iew to enhancing the value of the guide for educational urposes, have issued it in two forms, *i.e.* with and without plates; the former is published at the ridiculously w price of one shilling, and the latter at sixpence. aper and printing leave nothing to be desired.

OUR BOOK SHELF.

An Introduction to Practical Physics for Use in Schools. By D. Rintoul, M.A. Pp. xx + 166. (London: Macmillan and Co., Ltd., 1898.)

SO many volumes containing courses of work in practical physics have lately appeared, that it would hardly seem necessary to increase their number. But a critical examination of the present volume is sufficient to afford justification for adding the book to those previously available. The author succeeded Prof. Worthington at Clifton College, and has carried on the work commenced there of making practical physics a subject practicable for junior students. The experiments described are thus not of the kind invented by the arm-chair philosopher—now happily becoming extinct—but those which have stood the test of experience, and have proved to be suitable for the class of students expected to perform them.

The book does not provide a complete course of practical work in physics, but only on some branches of physical measurement. Experiments on mensuration and hydrostatics occupy fifty-four pages, heat is dealt with in fifty-seven pages, and the third part on dynamics fills fifty-three pages. Light, sound, electricity, and magnetism are not touched upon, but presumably they will form the subject of a second volume. There can, however, be no doubt that the subjects included in the present volume are fundamental for students of physics, and form the best basis for future work.

The plan adopted by Mr. Rintoul, and proved by him to be suited to the mental capacity of boys of thirteen or fourteen, is a compromise between the Socratic and didactic methods of teaching. Sufficient explanation is given to enable the young experimenter to proceed with his work intelligently, and to grasp the significance of the results. He is then in a position to understand the effects produced by different conditions; and Mr. Rintoul provides him with many questions upon which he can usefully exercise his mind.

The book is especially suitable for the modern sides of public schools. As a physical laboratory manual for use in schools of this character it can be highly commended.

A Text-book of Special Pathological Anatomy. By Prof. Ernst Ziegler. Translated and edited from the eighth German edition by Donald Macalister, M.A., M.D., and Henry W. Cattell, M.A., M.D. Sections i.-viii., and ix.-xv., in two vols. (London: Macmillan and Co., Ltd., 1897. New York: The Macmillan Company.)

THE first English edition of Ziegler's "Pathological Anatomy" was published in 1884, and at once achieved the success in this country which the original work had already attained in Germany. It is without doubt the best work in pathological anatomy in English. The present edition, translated and edited from the eighth German edition, brings the ever-increasing subject of pathological anatomy up to date, and it may be said at once that the editors have done their work in an excellent and lucid manner. The two volumes under review deal with the pathological changes occurring in particular parts of the body; and with an aspect of the subject which is of great importance to the practitioner, and of great value to the professed pathologist. The latter will find in the work copious references to the literature of each special part of the subject, arranged in a very useful manner. The ordinary medical student will perhaps find the present work (which will be followed by a third volume) too large for his purpose, but for the student for a university degree, and for the working pathologist, Ziegler's "Pathological Anatomy" is a necessity.

Eclipses of the Moon in India. By Robert Sewell, late of her Majesty's Indian Civil Service, Member of the Royal Asiatic Society, &c. Pp. 13; tables lx. London: Swan Sonnenschein and Co., Ltd, 1898.)

THIS work is in fact a continuation and completion of Mr. Sewell's "Indian Calendar," which was noticed in NATURE for July 9, 1896 (vol. liv. p. 219). The principal matter (besides some notes and additions to the Calendar), is a table of the times, durations, and magnitudes of all eclipses of the moon (whether visible or not in India) for the period of sixteen hundred years, from A.D. 300 to A.D. 1900. The times are reduced to the Hindu prime meridian, that of Lairka (Ujjain), the longitude of which is 75° 46′ east of Greenwich, and are reckoned from mean sunrise (taken as 6h. a.m.) at that place. The calculations are founded on Oppolzer's "Canon der Finsternisse"; but another table gives the figures reduced from the *Nautical Almanac* from its commencement in 1767 (or rather 1768, as no eclipse of the moon occurred in the former year), though the figures in the "Canon" are probably more accurate than those in the Almanac before the year 1819 (not 1821), when Burckhardt's lunar tables were first brought into use in the latter. Mr. Sewell has not thought it necessary to mark the magnitude of an eclipse as greater than total, simply affixing to all such the letter "t." He acknowledges the help in the calculations afforded by Saukara Balkrishna Dikshit, formerly Pandit of the Training College, Poona, whose co-operation was so valuable in his work on the "Indian Calendar," and whose death took place early in the present year; and also expresses his thanks for kind advice and assistance given by Prof. Turner (of Oxford) and Mr. Crommelin (of the Royal Observatory, Greenwich). The precautions taken have probably secured that accuracy which is so particularly essential in matters of this kind; here we will merely point out two errors in p. 4 of the Introduction, where "fixtures" is printed instead of "figures," and Burckhardt's name is spelt without a "k," though Mr. Sewell is liberal of that letter in retaining the obsolete method of spelling "Almanack" with one.

W. T. LYNN.

Famous Problems of Elementary Geometry. By Felix Klein. Translated by W. W. Beman and D. E. Smith. Pp. ix + 80. (London: Ginn and Co., 1897.)

OUR mathematical readers who do not read German will be glad to know that they have now before them a translation of a discussion of three famous geometric problems of antiquity, namely, the duplication of the cube, the trisection of an angle, and the quadrature of the circle as seen through modern eyes. This discussion took place at Göttingen at a meeting of the German Association for the Advancement of the Teaching of Mathematics and the Natural Sciences, and was presented by the great German mathematician, Prof. Felix Klein, with the purpose of bringing the study of mathematics in the university and gymnasium into closer connection. Such an important work as this will doubtless be read very widely, and the joint translators have done good service in making this discussion more available by the excellent translation we have before us.

The Evolution of the Aryan. By R. von Ihering. Translated by A. Drucker. Pp. xviii + 412. (London: Sonnenschein and Co., Ltd., 1897.)

MR. A. DRUCKER has given us a translation of an unfinished work by the late Prof. von Ihering. Much of the argument of the book depends on theories which the leaders of linguistic science have now abandoned. Philologers now confess that community of language does not necessarily imply community of race, and Orientalists and other linguists are hopelessly at variance regarding the "Urheimat" of our race; the book, though ignoring all this, contains much wide reading and keen observation. This is apparent in matters relating to Greek, and especially to Roman, civilisation, the author's special province. In some cases a more intimate knowledge of things Indian would have improved his argument. Thus the Pali Bāveru-jātaka, known to students of folk-lore, is a very important and early witness from the Indian side to commerce between India and Babylon. The "corrective stake" (pp. 54, 55) is also illustrated by the punitive heated pillar (*sūrmi*), mentioned by Manu and earlier authorities.

Mr. Drucker's English is free and lucid; one may quite forget that one is reading a German work on science. In the first sentence of his preface, is not "latest Sanskrit and earliest Babylonian" a slip for the reverse expression?

C. B.

First Lessons in Modern Geology. By the late A. H. Green, M.A, F.R.S. Edited by J. F. Blake, M.A. Pp. viii + 208. (Oxford: The Clarendon Press, 1898.)

THE manuscript of this book was left by the late Prof. Green in a somewhat unfinished condition, and the editor was asked to prepare it for the press. The book is described in the preface as being practically a primer, yet in the third lesson, dealing, among other matters, with the constitution of quartz, after the barest statement of the proportion by weight in which silicon and oxygen combine chemically, and the introduction, with no explanation, of the term "atomic weights," we read: "All this the chemist would express shortly by writing for silica SiO_2; Si standing for twenty-eight parts by weight of silicon, O for sixteen parts by weight of oxygen, and the 2 under the O showing that in silica the oxygen is in the proportion of *twice* sixteen. SiO_2 is called the chemical formula for silica." Is this the kind of information to place before a beginner receiving his third lesson in geology? Later on in the same lesson the chemical composition of orthoclase is dealt with in a similar manner. If the beginner himself were consulted, we imagine his third lesson in geology would be his last. Had the editor omitted these little digressions, which cannot be understood by mere reading, the educational value and the interest of the book would have been much enhanced.

First Stage Inorganic Chemistry (Practical). By Frederick Beddow, D.Sc., Ph.D. Pp. viii + 165. (London: W. B. Clive.)

THE course of practical work contained in this volume follows the elementary syllabus of the Science and Art Department's examination in inorganic practical chemistry. The syllabus gives the outlines of a reasonable course of laboratory work: and therefore the present volume, like others constructed upon the same lines, has several good features. After a few introductory experiments in manipulation, and exemplifying characteristic properties of some common substances, the preparation and properties of a number of common elements and compounds are described. Following this are experiments on the action of heat, water, and acids on some familiar substances, simple quantitative experiments, and exercises in systematic analysis. The volume thus provides elementary students with an instructive course of work in practical chemistry.

Marvels of Ant Life. By W. F. Kirby, F.L.S., F.E.S. Pp. viii + 174. (London: S. W. Partridge and Co., 1898.)

ANTS and their habits form a subject of perennial interest to general readers, so Mr. Kirby's popular account of the more remarkable phases of ant life should be successful. The text is lightly written, for the benefit of general readers who are entirely unfamiliar with insect life in its scientific aspects; but there is also much in it to interest attentive students of natural history.

LETTERS TO THE EDITOR.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

The Spectrum of Krypton.

PROF. RUNGE, in your last issue, points out that the wave-length of the bright green line of krypton is 5570·4 (Rowland's scale), while that of the auroral line is about 5571. In the paper presented to the Royal Society by Dr. Travers and myself on June 3, the wave-length is given as 5567·7. The wave-length was re-measured by Mr. Baly on June 7, and its value was found to be 5570·0. That of the feebler green was 5561·8, and of D_4, the yellow line, 5870·0. These values, read by means of a grating, are very close to those given by Prof. Runge. We hope to publish photographic measurements of the other lines shortly.

WILLIAM RAMSAY.

University College, London, November 15.

Stereochemistry and Vitalism.

ALTHOUGH Prof. Japp has already replied to the criticisms which have appeared in NATURE on his address to the Chemical Section of the British Association, we should be glad, in view of the interest taken in the matter, and also because we have been investigating externally compensated and optically active compounds for some years past, if you could find space in which we may continue the discussion and bring forward a few facts in support of our views.

In the first place, we will briefly summarise the main points on which there seems to be general agreement, as follows:—Compounds, optically inactive by external compensation, can be prepared under symmetric conditions—such compounds, under suitable and symmetric conditions may separate from solution in enantiomorphously related crystals; under symmetric conditions crystals of the two enantiomorphs are deposited in equal numbers, and the crystalline deposit as a whole, as well as the mother liquor, if separated, are both optically inactive.

Now Prof. Japp contended that, in order to obtain an optically active deposit or mother liquor from such an externally compensated compound (without the aid of some pre-existing asymmetric influence), an intelligently selective or vital force must be called into action, and consequently that vitalism determined the existence of optically active compounds in nature; in his reply he modifies his original contention by introducing the word "constantly"; but this modification makes very little, if any, difference to the arguments which we adduce. His critics, on the other hand, have attempted to show, with what success we do not venture to express an opinion, that chance alone, or other causes apart from vitalism, may have brought about the present occurrence of enantiomorphous compounds in organised nature.

Having frequently had occasion to study the spontaneous crystallisation of externally compensated substances, we had in mind various observations, especially some made during recent work, which led us, from the first, to doubt the validity of Prof. Japp's views. Let us consider, in the first instance, the case of sodium chlorate, a substance which separates from solution in enantiomorphously related crystals. On allowing saturated solutions of this salt to crystallise spontaneously, we found that in only two experiments out of forty-six were equal numbers of dextro-and laevo-rotatory crystals deposited (*Trans. Chem. Soc.*, 1898, 606), the percentage of dextro-rotatory crystals in the 46 crops varying from 24·14 to 77·36; nevertheless, the weighted mean percentage of dextro-rotatory crystals obtained was 50·08 ± 0·11. It is obvious, therefore, that on crystallising this substance under symmetric conditions equal numbers of dextro-and laevo-rotatory crystals are finally obtained, and yet in a single deposit one or other form may be present in large excess.

On the publication of Prof. Japp's address, we hastened to obtain further experimental evidence bearing on this point. For this purpose a saturated solution of sodium chlorate was allowed to evaporate spontaneously, three unselected crystals of the salt of unknown rotation being introduced as nuclei; after a week's time each of the three crystals had grown to a large size, and was very well developed. One of these, weighing 47 grams, was removed from the solution and broken into small pieces which were seeded into saturated solutions of the chlorate; the latter were then placed aside to crystallise. After a week's time these solutions were full of well-developed crystals, which were removed and examined; the crystals were 269 in number, and were all dextro-rotatory.

This experiment shows that an enantiomorphous system may originate from a non-enantiomorphous one without the introduction of any intelligently directive or enantiomorphous influence, and under conditions which might well arise in an inorganic non-enantiomorphous universe. This being so, it is illogical to assume in the present rudimentary state of our knowledge of the subject that enantiomorphism of this kind could not cause enantiomorphism in a system containing a substance such as racemic acid or some other externally compensated compound

Now, although a solution of sodium chlorate deposits on the average equal numbers of dextro-and laevo-rotatory crystals, this does not preclude the possibility of other similar compounds which separate from solution in enantiomorphously related crystals giving a preponderance of one or other form, owing possibly to enantiomorphous influences exerted by surrounding conditions, such, for example, as the earth's enantiomorphism; in fact, as we have already pointed out (*Trans. Chem. Soc.*, 1898, 611), observations in support of this view are not lacking, although they require, and are now receiving, further examination.

We have also shown (*Proc. Chem. Soc.*, 1898, 113) that, apparently, a close analogy exists between the behaviour of sodium chlorate and of an externally compensated mixture of dextro- and laevo-rotatory sodium ammonium tartrates; this parallel we are at present investigating. The first step in our examination of sodium chlorate was to ascertain the ratio between the numbers of dextro- and laevo-rotatory crystals deposited from solution, with the results briefly summarised above; obviously a similar step is necessary in the case of the mixed tartrates. The results which have been obtained in these experiments contrast remarkably with those recorded in the case of sodium chlorate, and are absolutely at variance with the views expressed by Prof. Japp. Ten such solutions have so far been examined, and in every case a strongly dextro-rotatory deposit was obtained, the mother liquor, of course, being strongly laevo-rotatory. We put these experimental results forward with considerable reservation as the work is not complete and we may discover some disturbing influence; but, inasmuch as attention has of late been concentrated on this fascinating subject by Prof. Japp's equally fascinating presentment of it, we feel compelled to make this short statement of the results up to the present obtained in developing the work which we have in hand.

Much more might be written with a view to suggesting the possible sequence of events which might have led to the present conditions of organised nature, but it is of little use attempting such a task until a great deal more experimental evidence is before us.

F. STANLEY KIPPING.
WILLIAM J. POPE.

THE following seems to me a perfectly possible, although purely hypothetical, way in which any amount of an optically active compound could be formed by chance chemical processes.

Let an admixture of chemical compounds be such that only one molecule of an optically active compound is formed. Or, if you like, let a volcanic explosion scatter a collection of equal quantities of dextro and laevo molecules in such a way that one molecule only falls in a certain pool of water containing inactive bodies in solution.

This single molecule must be either dextro or laevo. Let us suppose it is a dextro molecule.

Furthermore, let it be of such a nature that it can react catalytically with surrounding molecules in such a way as to produce in these an asymmetric atom:

e.g.

$$(1)\quad \begin{array}{l} \mathrm{C}d_2 \\ \| \\ \mathrm{C}ab \end{array} + \mathrm{RH}_2 = \begin{array}{l} \mathrm{C}d_2\mathrm{H} \\ | \\ \underline{\underline{\mathrm{C}}}ab\mathrm{RH} \end{array}.$$

$$(2)\quad \begin{array}{l} \mathrm{C}d_2\mathrm{H} \\ | \\ \underline{\underline{\mathrm{C}}}ab\mathrm{RH} \end{array} + \mathrm{H}_2 = \begin{array}{l} \mathrm{C}d_2\mathrm{H} \\ | \\ \underline{\underline{\mathrm{C}}}ab\mathrm{H} \end{array} + \mathrm{RH},$$

where *abcd* are any monovalent radical not containing an asymmetric carbon atom, while R is a dextro-rotatory bivalent radical. The first molecule formed, according to equation (1), will have the underlined C dextro or laevo, being determined by R being dextro.

When this decomposes according to equation (2) the $\underline{\underline{C}}$ will still be active, and one active molecule of $\begin{array}{l} \mathrm{C}d_2\mathrm{H} \\ \vert \\ \underline{\underline{\mathrm{C}}}ab\mathrm{H} \end{array}$ will have been produced.

But RH_2 is reproduced, and is consequently capable of repeating this action indefinitely, and of making an indefinite number of $\begin{array}{l} \mathrm{C}d_2\mathrm{H} \\ \vert \\ \underline{\underline{\mathrm{C}}}ab\mathrm{H} \end{array}$ molecules with activity of the same sign.

Furthermore, this action is scarcely to be distinguished in principle from the reactions brought about by unorganised ferments or enzymes.

W. M. Strong.

Helstonleigh, Champion Park, Denmark Hill, S.E., November 1.

It appears to me that Prof. Kipping and Mr. Pope unintentionally attribute to me opinions which I have never expressed, and which I do not hold. I never for a moment imagined that *in each separate crystallisation*—either of molecularly symmetric substances which, like sodium chlorate, may form either right-handed or left-handed crystals, or of the externally compensated mixture of dextro- and laevo-rotatory sodium ammonium tartrates, in which the asymmetry is molecular—equal amounts of the two kinds of crystals would necessarily be deposited. I never thought of this equality as holding good, except as the mean of a great number of experiments. In my address, when referring to Messrs. Kipping and Pope's results obtained with sodium chlorate, I therefore used the expression "on the average." Besides, I was acquainted with Landolt's experiments on the subject, which prove the same thing. In the case of the dextro- and laevo-rotatory sodium ammonium tartrates, the Pasteur-Gernez method of separating these by starting the crystallisation with a crystal of one of the two kinds, and Jungfleisch's experiments, to which I will refer more fully later on, were sufficient to make me aware of the influence of initial bias on crystallisation, and to prevent me from expecting equality, except as a mean result.

In fact, in these crystallisations everything depends on this initial bias; and in this respect, Landolt's experiments are especially instructive. His method (*Ber. d. deutsch. chem. Ges.*, 1896, p. 2410) consists in precipitating aqueous solutions of sodium chlorate by addition of alcohol. A magma of minute crystals is thus obtained, each of which must be either right-handed or left-handed. The crystals are then separated and ground to a fine powder; and this powder, suspended in a mixture of alcohol and carbon disulphide, is examined in the polarimeter. If both enantiomorphous forms are present in equal quantity, there will be no rotatory effect; whereas a preponderance of either form will be indicated by a rotation in the corresponding sense.

Landolt found that if the precipitation was rapidly effected by the sudden addition of alcohol, the powder was either inactive, or had a very feeble rotation. On the other hand, if the alcohol was gradually added, so as to produce slow precipitation, the powder displayed a marked rotation, which was in some cases right-handed, in others left-handed. The reason is obvious. In the former case, the crystallisation starts simultaneously from a vast number of independent centres; the chances are equal in favour of each centre being right-handed or left-handed; each centre will propagate its own kind; and thus the ratio of right-handed to left-handed forms will not differ very appreciably from unity. In the latter case, as Landolt points out, the crystallisation starts from only a few centres; in these, therefore, either the right-handed or the left-handed form may predominate, and, as sufficient time is given, the dominant form will influence the course of the crystallisation.

In Messrs. Kipping and Pope's slow crystallisations, every opportunity is afforded for any initial asymmetric bias to exercise its influence; and I should have been greatly surprised if the authors had obtained a result other than that which they describe.

There is, therefore, a marked difference between the formation of enantiomorphous crystals and of enantiomorphous molecules respectively, under symmetric conditions: namely, that the crystals propagate their own asymmetry, whilst the molecules, as I pointed out in my reply to Prof. Karl Pearson, do not—at least, so far as experiment informs us.

In the crystallisation of the externally compensated mixture of dextro- and laevo-rotatory sodium ammonium tartrates, one would expect a similar state of things to prevail, modified however by the circumstance that in this case, the two opposite asymmetries of the molecules themselves are pre-existent in the solution and must influence the result. One would expect variations, within limits, of the relative quantities of dextro- and laevo-salts deposited; but according to our present views, *the mean variations should occur equally in opposite directions.*

It is therefore with great surprise that I learn that in the ten experiments which Messrs. Kipping and Pope have hitherto made on this point they obtained in every case a strongly dextro-rotatory deposit. It is true that Jungfleisch (compare *Chem. News*, vol. 40, p. 231) published, in 1884, similar results. Jungfleisch's procedure was somewhat different from that of Messrs. Kipping and Pope. Instead of allowing the solution to crystallise spontaneously, he introduced simultaneously into the supersaturated solution, at opposite sides of the crystallising dish, a crystal of the dextro-rotatory and one of the laevo-rotatory salt. In all his experiments the former crystal increased in weight, and the mother liquor contained a corresponding excess of the laevo-salt. I confess that I have always attributed Jungfleisch's results to mere coincidence. It will doubtless be within Prof. Kipping's recollection that in April last I wrote to him calling his attention to these results, in connection with his joint work with Mr. Pope. Prof. Kipping replied (I quote from memory), that Jungfleisch's results were opposed to all that was known of the behaviour of enantiomorphs; that he (Prof. Kipping) did not regard them as conclusive; and that he proposed to repeat them. This he and Mr. Pope have now done; but from what I have just said, it is evident that the outcome of this repetition must have been as great a surprise to him as it is to me. I am glad to find, however, that the authors put forward their results with reserve, and that they contemplate the possibility of discovering some disturbing influence. If no such influence is at work, it is not merely the small matter of my particular application of the principles of molecular asymmetry that will have to go: it is these principles themselves. But I do not anticipate any such catastrophe. The vast accumulation of verified prediction of which the science of stereochemistry can boast, does not point to premises so unsound.

I will wait, therefore, for further light on Messrs. Kipping and Pope's later experiments before drawing any conclusion from them. As regards the experiments with sodium chlorate, I am at a loss to understand in what way they militate against my views. I no more expect equal numbers of right and left crystals to separate in any given crystallisation of sodium chlorate than I expect an unvarying alternation of heads and tails in tossing a coin. Nor do I perceive the application of the experiment in which they obtained none but right-handed crystals of the chlorate; inasmuch as, if they go on repeating it, they will obtain, just as often, none but left-handed crystals. The process will not *constantly* yield the same form.

I must also repeat that I do not regard the spontaneous formation of "optically active mother liquors," or other partial separations of enantiomorphs, especially when the separation may occur in either direction, as a solution of the problem. The separation of enantiomorphs in the living world is, in the overwhelming majority of cases, as I have pointed out in a previous reply, not partial but *total;* and it occurs *constantly* in one direction—only one form survives. This is another case where the word "constantly" applies—a word quoted by the authors, but otherwise ignored by them, except where they are discussing experiments which they themselves regard as requiring confirmation.

I think, moreover, that my critics might in justice take into account the disadvantage under which I laboured in having to compress into the limits of a brief address an account of a subject so vast and intricate. Many of my statements of important points were necessarily somewhat summary and inadequate: and most of the misunderstandings into which my various critics have fallen are, I am aware, due to this circumstance.

The University, Aberdeen, November 10.

F. R. Japp.

MR. STRONG'S suggestion is very ingenious, and I must admit that, *granting his premises*, the chance production of an unlimited quantity of a single asymmetric compound is conceivable. I had not thought of the possibility of one asymmetric molecule acting as a catalytic agent in the way he suggests. It would, however, have been perhaps simpler and more in accordance with the behaviour of enzymes, with which class of ferments he compares this supposed catalytic agent, if he had represented the second stage of the process as a hydrolysis; in which case, of course, the asymmetric group of the resulting compound would have contained hydroxyl in place of hydrogen.

Mr. Strong admits that the process is "purely hypothetical." I think I should go further than this, and say that, considered as an actual process occurring under chance conditions, it is grotesquely improbable.

The "volcanic explosion" carrying "one molecule" of an asymmetric compound into "a certain pool of water," seems to be a reproduction (on a reduced scale) of Prof. Errera's "vortex" which whirls "one simply asymmetric particle" into a particular "planet" (see NATURE, vol. lviii. p. 616, col. 2). F. R. JAPP.

The University, Aberdeen, November 5.

Mental Calculations of a High Order.

THERE are probably among your readers some who are interested, by curiosity or for scientific purposes, in freaks of memory. I am not sure that what my memory has done is remarkable, although it is quite novel to me.

For many years I have been in the habit of using some useless exercise in mental gymnastics to divert my mind from the occupations of the day, and so get quickly asleep. Sometimes it would be extracting the letters of the alphabet successively from some passage in prose or poetry, keeping the number of each letter in mind, and finally counting all the letters in the passage, to make sure that I had allowed no letter to pass by me unnoticed. Again, I would try to think of all the famous poets, or generals, or sovereigns, or statesmen of all time, whom I could recall, in alphabetical order. Whatever might be the task I undertook I resumed it night after night, beginning as nearly as possible where I left off, and continue until I had completed it.

About a year ago the fancy took me to see how far I could go in raising, by mental process only, the number 3 to its high powers. At the beginning I would not have believed it possible to remember fifteen figures in their order. To my surprise I succeeded in raising 3 to the 44th power, making, if I remember rightly, a number of 22 figures. I did it by successive multiplications by 3, and without shortening the process in any way. I did not put a figure on paper until I had reached the 24th power; but always proved every result as far as I could by the nine test—a safeguard against substantially every error save those that might arise from transposition of figures. At the point mentioned I set the product down, and performed on paper this short process:

$$3^2 = 9;\ 3^4 = 81;\ 3^8 = 6561;\ 3^{24} = 6561 \times 6561 \times 6561.$$

As my mental result was wrong in four or five figures in the middle, so to speak, I knew that I must have transposed two figures somewhere between power 15 and power 20, so I went back and began over again. At the 24th power I was right, and so I was when I reached the 44th power.

That seemed to be as far as it was worth while to go, and I then began a more difficult exercise: to ascertain, as in permutations, the product of the numbers from one upward as far as I could go. I have carried the process up to, and including the number 37. The product is a number of 44 figures, whereof the last eight are 0's, which do not add to the effort of memory to retain them. To remember 36 digits in their correct order may not be a wonderful feat; it is so easy to me that I do not suppose it is unusual. But I can now remember, and have to-day written down and then repeated to my stenographer, successively, the product of the numbers to 35, to 36, and to 37, having respectively 33, 34 and 36 figures, beside the eight 0's with which each number ends, or 103 figures in all. How much further I could carry the process I do not know; I do not purpose attempting to ascertain.

I will add some facts that may be interesting.

(1) I verify my result after each multiplication: first, by proving that the sum of all the digits is a multiple of 9; secondly, by dividing it by 7, 11 and 13, not attempting to remember the quotient, but only the successive remainders, to be sure that the number divides evenly.

(2) Almost every product has some peculiar combination of numbers. For example, in the 35 result there are four 6's together; in the 36 the figures 6789 occur; the first six figures of the 37 product are 137,637; and so on.

(3) The work is done in groups of three figures, and almost every new factor in the multiplication gives some short process of multiplying. Before I begun with 37 it seemed impossible to multiply 34 figures by such a number, odd, large, and a prime number. But the fact that $37 \times 3 = 111$ soon suggested the way to make the process easy. The last nine figures (omitting 0's) of the 36 product are 481,508,352. Now $352 = 360 (3 \times 12 \times 10) - 8$. Then we have $111 \times 12 = 1332 \times 10 = 13,320$. $37 \times 8 = 296$. $13,320 - 296 = 13,024$. The multiplication of the next group is easy. $37 \times 500 = 18500$; add 296 $(37 \times 8) + 13$ ("carried") $= 18,809$. The next group, 481, is taken as $= 500 - 20 + 1$, and the number with the 18 "carried" from the last multiplication becomes 17,815,809,024.

(4) Does this exercise put me to sleep? O, yes, very quickly!

Boston, U.S.A., October 24. E. S.

The Leonids in 1868.

I WITNESSED the magnificent shower of Leonid meteors on the night of November 13–14, 1866. But I do not recollect seeing any published account of such a display in England in 1868. It occurs to me that the following observations may be worth publishing.

On November 5 in that year I was in Venice. Returning through Milan, I crossed the Alps in a sledge by the St. Gothard in a terrible snow-storm on the 7th, and reached Calais at midnight on the 13th. Neither sun, moon, nor stars had been visible since I left Venice. The Calais boat started for Dover about 1h. 30m. on the morning of the 14th. As we were leaving the port the clouds suddenly cleared off, and a splendid display of Leonids was visible. I judged the shower to be in every respect equal to that of 1866. Some of them were as bright as Jupiter, and left long trails in the sky which took two or three minutes to dissolve. The display kept up until we were within a couple of miles of Dover, when the clouds suddenly came on again and the sky was completely obscured.

Coventry, November 12. WM. ANDREWS.

The Smell of Earth.

"SEE, the smell of my son is as the smell of a field which the Lord hath blessed." Thus poetically spoke the Patriarch Isaac. The man of modern science tells us, prosaically, that the odour of moist earth is due to a bacterium, named *Cladothrix odorifera*. I write to ask if any one has yet accounted for the well-known and peculiar odour, yielded by clay and clayey rocks when breathed upon. This odour can scarcely be due to bacteria, for it is manifested by cabinet specimens more than twenty years old. Pure alumina appears to be odourless.

Leeds, November 12. C. T. WHITMELL.

Breath-Figure of Spider's Web.

A FEW mornings ago I noticed in my bath-room a spider's web spun right across one pane of the window, but not in actual contact with the glass, there being room for a house-fly to buzz up and down the pane without touching the meshes. My morning ablutions giving rise to some considerable quantity of vapour, I observed a very distinct breath-figure of the spider's web upon the glass. I accordingly removed the web and the spider. Next morning, in the absence of the web, on the renewal of the vapour conditions the breath-figure reappeared. I then wiped one half of the window dry with a towel. Now, after five mornings, the breath-figure is quite distinct upon the half which was not touched, and can be faintly seen on the wiped portion. OSWALD H. LATTER.

Charterhouse, Godalming, November 13.

A Second Crop of Apples.

I THINK perhaps it may be worth noting that apple-blossom was gathered in the neighbourhood of Exeter last week. Still more remarkable is the fact that a second crop of apples has made fair progress, as some at the farm of Gràs Lawn, close to the city, some "Red Quaranders" have been gathered, nearly the size of walnuts. Two of these, now somewhat shrivelled, are enclosed. JAMES DALLAS.

Exeter, October 14.

CONTINUITY OF WAVE THEORIES.[1]

CONSIDER the following three analogous cases:—I. mechanical, II. electrical, III. electromagnetic.

I. Imagine an ideally rigid globe of solid platinum of 12 centim. diameter, hung inside an ideal rigid massless spherical shell of 13 centim. internal diameter, and of any convenient thickness. Let this shell be hung in air or under water by a very long cord, or let it be embedded in a great block of glass, or rock, or other elastic solid, electrically conductive or non-conductive, transparent or non-transparent for light.

I. (1) By proper application of force between the shell and the nucleus cause the shell and nucleus to vibrate in opposite directions with simple harmonic motion through a relative total range of 10^{-3} of a centimetre. We shall first suppose the shell to be in air. In this case, because of the small density of air compared with that of platinum, the relative total range will be practically that of the shell, and the nucleus may be considered as almost absolutely fixed. If the period is $\frac{1}{32}$ of a second, frequency 32 according to Lord Rayleigh's designation, a humming sound will be heard, certainly not excessively loud, but probably amply audible to an ear within a metre or half a metre of the shell. Increase the frequency to 256, and a very loud sound of the well-known musical character (C_{256}) will be heard.[2]

Increase the frequency now to 32 times this, that is to 8192 periods per second, and an exceedingly loud note 5 octaves higher will be heard. It may be too loud a shriek to be tolerable; if so, diminish the range till the sound is not too loud. Increase the frequency now successively according to the ratios of the diatonic scale, and the well-known musical notes will be each clearly and perfectly perceived through the whole of this octave. To some or all ears the musical notes will still be clear up to the G (24756 periods per second) of the octave above, but we do not know from experience what kind of sound the ear would perceive for higher frequencies than 25000. We can scarcely believe that it would hear nothing, if the amplitude of the motion is suitable.

To produce such relative motions of shell and nucleus as we have been considering, whether the shell is embedded in air, or water, or glass, or rock, or metal, a certain amount of work, not extravagantly great, must be done to supply the energy for the waves (both condensational and rarefactional), which are caused to proceed outwards in all directions. Suppose now, for example, we find how much work per second is required to maintain vibration with a frequency of 1000 periods per second, through total relative motion of 10^{-3} of a centimetre. Keeping to the same rate of doing work, raise the frequency to 10^4, 10^5, 10^6, 10^9, 10^{12}, 500×10^{12}. We now hear nothing; and we see nothing from any point of view in the line of the vibration of the centre of the shell which I shall call the axial line. But from all points of view, not in this line, we see a luminous point of homogeneous polarised yellow light, as it were in the centre of the shell, with increasing brilliance as we pass from any point of the axial line to the equatorial plane, keeping at equal distances from the centre. The line of vibration is everywhere in the meridional plane, and perpendicular to the line drawn to the centre.

When the vibrating shell is surrounded by air, or water, or other fluid, and when the vibrations are of moderate frequency, or of anything less than a few hundred thousand periods per second, the waves proceeding outwards are condensational-rarefactional, with zero of alternate condensation and rarefaction at every point of the equatorial plane and maximum in the axial line. When the vibrating shell is embedded in an elastic solid extending to vast distances in all directions from it, two sets of waves, distortional and condensational-rarefactional, according respectively to the two descriptions which have been before us, proceed outwards with different velocities, that of the former essentially less than that of the latter in all known elastic solids.[1] Each of these propagational velocities is certainly independent of the frequency up to 10^4, 10^5, or 10^6, and probably up to any frequency not so high but that the wave-length is a large multiple of the distance from molecule to molecule of the solid. When we rise to frequencies of 4×10^{12}, 400×10^{12}, 800×10^{12}, and 3000×10^{12}, corresponding to the already known range of long-period invisible radiant heat, of visible light, and of ultra-violet light, what becomes of the condensational-rarefactional waves which we have been considering? How and about what range do we pass from the propagational velocities of 3 kilometres per second for distortional waves in glass, or 5 kilometres per second for the condensational waves in glass, to the 200,000 kilometres per second for light in glass, and, perhaps, no condensational wave? Of one thing we may be quite sure; the transition is continuous. Is it probable (if aether is absolutely incompressible, it is certainly possible) that the condensational-rarefactional wave becomes less and less with frequencies of from 10^6 to 4×10^{12}, and that there is absolutely none of it for periodic disturbances of frequencies of from 4×10^{12} to 3000×10^{12}? There is nothing unnatural or fruitlessly ideal in our ideal shell, and in giving it so high a frequency as the 500×10^{12} of yellow light. It is absolutely certain that there is a definite dynamical theory for waves of light, to be enriched, not abolished, by electromagnetic theory; and it is interesting to find one certain line of transition from our distortional waves in glass, or metal, or rock, to our still better known waves of light.

I. (2) Here is another still simpler transition from the distortional waves in an elastic solid to waves of light. Still think of our massless rigid spherical shell, 13 centim. internal diameter, with our solid globe of platinum, 12 centim. diameter, hung in its interior. Instead of as formerly applying simple forces to produce to-and-fro rectilinear vibrations of shell and nucleus, apply now a proper mutual forcive between shell and nucleus to give them oscillatory rotations in contrary directions. If the shell is hung in air or water, we should have a propagation outwards of disturbance due to viscosity, very interesting in itself; but we should have no motion that we know of appropriate to our present subject until we rise to frequencies of 10^9, 10×10^{12}, 400×12^{12}, 800×10^{12}, or 3000×10^{12}, when we should have radiant heat, or visible light, or ultra-violet light proceeding from the outer surface of the shell, as it were from a point-source of light at the centre, with a character of polarisation which we shall thoroughly consider a little later. But now let our massless shell be embedded far in the interior of a vast mass of glass, or metal, or rock, or of any homogeneous elastic solid, firmly attached to it all round, so that neither splitting away nor tangential slip shall be possible. Purely distortional waves will spread out in all directions except the axial. Suppose, to fix our ideas, we begin with vibrations of one-second period, and let the elastic solid be either glass or iron. At distances of hundreds of kilometres (that is to say, distances great in comparison with the wave-length and

[1] "Continuity in undulatory theory of condensational-rarefactional waves in gases, liquids, and solids, of distortional waves in solids, of electric waves in all substances capable of transmitting them, and of radiant heat, visible light, ultra-violet light." Communicated by Lord Kelvin, G.C.V.O., being the substance of a communication to Section A of the British Association at its recent meeting in Bristol.

[2] Lord Rayleigh has found that with frequency 256, periodic condensation and rarefaction of the marvellously small amount 6×10^{-9} of an atmosphere, or "addition and subtraction of densities far less than those to be found in our highest vacua," gives a perfectly audible sound. The amplitude of the aerial vibration, on each side of zero, corresponding to this is $1{\cdot}27 \times 10^{-7}$ of a centimetre.—"Sound," vol. ii. p. 439 (second edition).

[1] "Math. and Phys. Papers," vol. iii., art. civ p. 522.

great in comparison with the radius of the shell), the wave-length will be approximately 3 kilometres.[1] Increase the frequency now to 1000 periods per second: at distances of hundreds of metres the wave-length will be about 3 metres. Increase now the frequency to 10^6 periods per second; the wave-length will be 3 millim., and this not only at distances of several times the radius of the shell, but throughout the elastic medium from close to the outer surface of the shell; because the wave-length now is a small fraction of the radius of the shell. Increase the frequency further to 1000×10^6 periods per second; the wave-length will be 3×10^{-3} of a millim., or 3 mikroms,[2] if, as in all probability is the case, the distance between the centres of contiguous molecules in glass and in iron is less than a five-hundredth of a mikrom. But it is probable that the distance between centres of contiguous molecules in glass and in iron is greater than 10^{-5} of a mikrom, and therefore it is probable that neither of these solids can transmit waves of distortional motion of their own ponderable matter, of so short a wave-length as 10^{-5} of a mikrom. Hence it is probable that if we increase the frequency of the rotational vibrations of our shell to one hundred thousand times 1000×10^6, that is to say, to 100×10^{12}, no distortional wave of motion of the ponderable matter can be transmitted outwards; but it seems quite certain that distortional waves of radiant heat in aether will be produced close to the boundary of the vibrating shell, although it is also probable that if the surrounding solid is either glass or iron, these waves will not be transmitted far outwards, but will be absorbed, that is to say, converted into non-undulatory thermal motions, within a few mikroms of their origin.

Lastly, suppose the elastic solid around our oscillating shell to be a concentric spherical shell of homogeneous glass of a few centimetres, or a few metres, thickness and of refractive index 1·5 for D light. Let the frequency of the oscillations be increased to $5·092 \times 10^{14}$ periods per second, or its period reduced to ·589212 of a michron: homogeneous yellow light of period equal to the mean of the periods of the two sodium lines will be propagated outwards through the glass with wave-length of about $\frac{2}{3} \times$ ·589212 of a mikrom, and out from the glass into air with wave-length of ·589212 of a mikrom. The light will be of maximum intensity in the equatorial plane and zero in either direction along the axis, and its plane of polarisation will be everywhere the meridional plane. It is interesting to remark that the axis of rotation of the aether for this case coincides everywhere with the line of vibration of the aether in the case first considered; that is to say, in the case in which the shell vibrated to and fro in a straight line, instead of, as in the second case, rotating through an infinitesimal angle round the same line.

A full mathematical investigation of the motion of the elastic medium at all distances from the originating shell, for each of the cases of I. (1) and I. (2), will be found in a volume containing my Baltimore Lectures on "Molecular Dynamics and the Wave-Theory of Light," soon, I hope, to be published.

II. An electrical analogy for I. (1) is presented by substituting for our massless shell an ideally rigid, infinitely massive shell of glass or other non-conductor of electricity, and for our massive platinum nucleus a massless non-conducting globe electrified with a given quantity of electricity. For simplicity we shall suppose our apparatus to be surrounded by air or aether. Vibrations to and fro in a straight line are to be maintained by force between shell and nucleus as in I. (1). Or, consider simply a fixed solid non-conducting globe coated with two circular caps of metal, leaving an equatorial non-conducting zone between them, and let thin wires from a distant alternate-current dynamo, or electrostatic inductor, give periodically varying opposite electrifications to the two caps. For moderate frequencies we have a periodic variation of electrostatic force in the air or aether surrounding the apparatus, which we can readily follow in imagination, and can measure by proper electrostatic measuring apparatus. Its phase, with moderate frequencies, is very exactly the same as that of the electric vibrator. Now suppose the frequency of the vibrator to be raised to several hundred million million periods per second. We shall have polarised light proceeding as if from an ideal point-source at the centre of the vibrator and answering fully to the description of I. (1). Does the phase of variation of the electrostatic force in the axial line outside the apparatus remain exactly the same as that of the vibrator? An affirmative answer to this question would mean that the velocity of propagation of electrostatic force is infinite. A negative answer would mean that there is a finite velocity of propagation for electrostatic force. This velocity, according to views regarding conceivable qualities of aether described in my article "On the Reflection and Refraction of Light" (*Phil. Mag.*, vol. xxvi. 1888) might be greater than, equal to, or less than the velocity of light.

III. The shell and interior electrified non-conducting massless globe being the same as in II., let now a forcive be applied between shell and nucleus to produce rotational oscillations as in I. (2). When the frequency of the oscillations is moderate, there will be no alteration of the electrostatic force and no perceptible magnetic force in the air or aether around our apparatus. Let now the frequency be raised to several hundred million million periods per second; we shall have visible polarised light proceeding as if from an ideal point-source at the centre and answering fully to the description of the light of I. (2) The same result would be obtained by taking simply a fixed solid non-conducting globe and laying on wire on its surface approximately along the circumferences of equidistant circles of latitude, and, by the use of a distant source (as in II.) sending an alternate current through this wire. In this case, while there is no manifestation of electrostatic force, there is strong alternating magnetic force, which in the space outside the globe is as if from an ideal infinitesimal magnet with alternating magnetisation, placed at the centre of the globe and with its magnetic axis in our axial line.

[1] "Math. and Phys. Papers," vol. iii. art. civ. p. 522.

[2] For a small unit of length Langley, fourteen years ago, used with great advantage and convenience the word "mikron" to denote the millionth of a metre. The letter *n* has no place in the metrical system, and I venture to suggest a change of spelling to "mikrom" for the millionth of a metre, after the analogy of the English usage for millionths (mikrohm, mikro-ampere, mikrovolt). For a conveniently small corresponding unit of time I further venture to suggest "michron" to denote the period of vibration of light whose wave-length in aether is 1 mikrom. Thus, the velocity of light in aether being 3×10^8 metres per second, the michron is $\frac{1}{3} \times 10^{-14}$ of a second, and the velocity of light is 1 mikrom of space per michron of time. Thus the frequency of the highest ultra-violet light investigated by Schumann (·1 of a mikrom wave-length, *Sitzungsber. d. k. Gesellsch. d. Wissensch. zu Wien*, cii. pp. 415 and 625, 1893) is 10 periods per michron of time. The period of sodium light (mean of lines D) is ·589212 of a michron; the periods of the "Reststrahlen" of rocksalt and sylvin found by Rubens and Aschkinass (*Wied. Ann.*, lxv. (1898, p. 241) are 51·2 and 61·1 michrons respectively.

No practical inconvenience can ever arise from any possible confusion, or momentary forgetfulness, in respect to the similarity of sound between michrons of time and mikroms of space.—K.

THE SERUM TREATMENT OF RINDERPEST.

THE Report of the Colonial Veterinary Surgeon and the Assistant Veterinary Surgeons of the Cape of Good Hope is at the present time a document of very considerable interest, as it is possible from the facts there set forth to form some definite opinion as to the efficacy of the various methods of protection and treatment against rinderpest that have been recommended in the Colony. It appears that there is now a possibility of completely eradicating rinderpest from South Africa, not,

however, by means of the bile method—which was originally introduced by Koch, and appears to induce only a temporary though "active" immunity against the disease—but by means of the use of a "serum."

Drs. Turner and Kollé have, as already reported in these columns, found that it is possible to treat rinderpest successfully with a serum taken from animals which have already suffered from the disease produced either artificially or naturally and reinforced artificially. As a result of their investigations they are now in a position, with the aid of this serum, to control the course of the disease when artificially produced. As animals which have suffered from the disease are immune for a very considerable period, and as an animal that passes through an attack controlled by the serum is protected or "salted," as it is termed, this method has been adopted very extensively for the purpose of protecting animals in affected and suspected districts, and it is probable that in time it will oust the bile method completely; especially as it seems to be attended by fewer disadvantages than accompany the latter method, and can be carried out at less cost and with less loss of life amongst the cattle.

In working with the serum method in rinderpest it is necessary to know as much about the serum used as it is in the case of the treatment of diphtheria with anti-diphtheric serum; but one would imagine that at the Cape, where such enormous financial interests are concerned, there should be no difficulty in obtaining pure serum, the value of which has been carefully estimated, for the treatment of cattle suffering from the earlier symptoms of rinderpest. The relative cost would be slight even were it necessary to have a series of stations from which serum might be obtained, and taking into consideration the fact that this serum might have to be thrown away periodically; and one can scarcely imagine that a method which is described as being nearly perfect, should be allowed to remain unused because there is some slight difficulty as regards the supply of money and laboratory accommodation. In connection with this part of the question, it may be mentioned that it has been proved by experiment that the serum remains quite active for at least seven months. How much longer, still remains to be proved.

It will be remembered that on a former occasion it was pointed out that "it is useless to attempt to infect whole herds which have been previously inoculated with bile, because it does not seem possible to give all such inoculated animals the disease simultaneously. Most of the cattle will become sick after injection of virulent blood, but many may remain unaffected, as the immunity conferred by the bile is still effective and protects them, and they will in consequence not become salted. In these herds the most satisfactory course to pursue is for the owner to obtain a sufficient supply of serum, and inject the cattle as soon as they are observed to be sick, or the thermometer indicates a rise of temperature. Cattle already sick require a larger dose of serum than those that are healthy, and in severe cases a second may be necessary." This, however, as pointed out by the Veterinary Surgeon, is only an indication that the serum must be injected at a still earlier stage than has hitherto been done, so that it is necessary to apply the serum treatment to a herd of cattle which has previously been inoculated with bile soon after the injection of the virulent blood. Cattle that would have reacted to the blood take the disease in a modified form, and become salted; whilst those that would not react are no worse off for the addition of the serum, and probably have a slight addition to their passive immunity. The principal Veterinary Surgeon points out that "the fact that the immunity conferred by bile is now wearing off, makes it necessary for the farmers to take prompt action when the disease appears in their herds, and the fact that the bile immunity has ceased, gives greater prospects of success attending the application of the serum as above indicated." He also points out that infection is not nearly so frequently carried from artificially infected herds as from those which take the disease naturally.

Bearing on this question, there is an interesting article in the August number of the *Agricultural Journal and Mining Record*, published in Natal. The injection of bile, unless very carefully selected and preserved, appears in many cases to have set up chronic abscesses, from the description of which one would have said that they were actinomycotic or discomycotic in character, though this is a question which appears to deserve further investigation. From the annual report of the Commissioner of Agriculture for the year 1897, which appears in the same journal, it is evident that the farmers are now thoroughly alive to the importance of using bile where serum cannot be obtained, but of having recourse to serum inoculation along with the injection of blood from diseased animals, when this method can be properly carried out. The only real drawback, and this is a very slight one indeed, appears to be that in a few cases the injected blood appears to set up some form of "red water," whilst in a few instances a malarial parasite may be transmitted along with the blood.

An idea of the expenditure on rinderpest for the year 1897 may be gathered from the fact that the outlay for fences, &c., was nearly 170,000*l*. A very small proportion of this, added to the laboratory and veterinary outlay, would enable the department to cope with this disease in future, and to save the Colony an enormous sum, both directly and indirectly. Mr. Watkins Pitchford, in his report, states that where the departmental instructions for the use of the serum have been adhered to, good "and often brilliant results have repeatedly been achieved," and that he is right in his conjecture is very evident from the fact that when the serum is given in definite quantity on one side and rinderpest blood on the other, but simultaneously, a reaction is invariably set up in an unsalted animal; and even when this reaction is not very severe, the nature of the disease is so well defined and the results so successful that the animal is perfectly salted for some time against natural infection, and frequently against the injection of rinderpest blood: the severest test to which the method can be put. He believes thoroughly in the permanent immunisation of the herds as a means of stamping out rinderpest; but immunisation with bile, he believes, would fail, although it may be useful as a temporary measure where serum cannot be obtained. It must be remembered, however, that the immunisation of the first animal must as a rule be through the use of bile. He is strongly in favour of maintaining a trustworthy supply of serum for the cases as they may appear, and for the immunisation of any stock in herds which have already passed through the disease, but in which the immunity is still not quite sufficient. Those who are most intimately acquainted with the history of rinderpest, and of the recent work on serum-therapy in connection with this disease, are now satisfied that the extinction of rinderpest amongst Cape cattle is already practically accomplished.

NOTES.

ON Friday last, November 11, the Chemical Society gave a banquet in honour of six of its Past-Presidents who had been for over half a century Fellows of the Society. The occasion was the more noteworthy that these eminent chemists—Gilbert, Frankland, Odling, Abel, Williamson, and Gladstone—are in many cases ranked among those whose teaching has most deeply influenced chemical science. As M. Friedel said: "They form the finest phalanx of the fathers of chemistry

which exists in any country." The season of the year prevented many foreign chemists from attending, but a great number of letters and telegrams were received. Amongst the men of science present were Prof. Armstrong, Sir J. Wolfe Barry, Sir G. Birdwood, Sir J. Crichton Browne, Dr. Böttinger, Major-General Sir Owen Tudor Burne, Dr. T. Lauder Brunton, the Vice-Chancellor of Cambridge University, Sir Ernest Clarke, Sir W. Crookes, Major-General Sir J. Donnelly, Prof. Wyndham Dunstan, Dr. Dupré, Dr. Dyer, Mr. T. H. Elliott, Mr. H. M. Elder, Sir John Evans, Major-General Festing, Prof. Michael Foster, Prof. P. Frankland, Sir Archibald Geikie, Mr. W. Gowland, Mr. C. E. Groves, Mr. W. Hills, Sir W. Huggins, Prof. Judd, Dr. W. Kellner, Lord Lister, Major P. A. MacMahon, the President of Magdalen, Prof. Herbert McLeod, Prof. Raphael Meldola, Dr. Rudolph Messel, Prof. H. A. Miers, Prof. G. M. Minchin, Dr. Ludwig Mond, Mr. J. Fletcher Moulton, Q.C., M.P., Dr. Hugo Müller, Sir A. Noble, Prof. W. Ostwald, Dr. W. H. Perkin and Prof. W. H. Perkin, the Master of Peterhouse, Dr. Pye-Smith, Mr. Boverton Redwood, Prof. Ramsay, Lord Rayleigh, Lord Reay, Prof. Roberts-Austen, Prof. Rücker, Dr. Russell, Prof. Smithells, Prof. Sprengel, Sir G. Gabriel Stokes, Mr. J. W. Swan, Prof. J. M. Thomson. Dr. Thorpe, Prof. Tilden, Mr Tyrer, and Sir H. Trueman Wood. We hope to give in another issue a full report of the speeches made on the occasion of this highly successful gathering.

AT the opening meeting of the new session of the Royal Geographical Society on Monday, the President, Sir Clements Markham, referred to the exploration of the Antarctic regions as the most important geographical work of our time. He remarked that the Antarctic agitation had spread over Europe, and was no longer confined to Great Britain. The Germans would certainly despatch an Antarctic expedition in 1900. Dr. Neumayer, the great authority on terrestrial magnetism, had been working with this end in view for years. A steam-vessel, specially designed and equipped for Antarctic service, would be built at Bremerhaven. The German Government would help with funds and in other ways, and would lend officers, even although they might have to go some distance from the end of a telegraph wire. Dr. Erich von Drygalski, the distinguished Greenland explorer, would lead the scientific staff. Dr. Neumayer looked to us for co-operation. They would understand now why they could not wait for Admiralty changes of policy. It ought to be a Government expedition under naval discipline. But if our navy was to be deprived of her right, the next best thing must be done; they must appeal to the country. The Council of the Society had resolved to head the list of subscriptions, even if its name should stand alone. There were numerous calls upon their funds, but they had resolved to strain them to the uttermost for that great national work. The Council would head the list with the sum of 5000*l*.

PROF. MICHAEL FOSTER and Prof. Rücker, Secretaries of the Royal Society, were present at the opening meeting of the Royal Geographical Society, and expressed the sympathy of the Royal Society in the movement for Antarctic exploration referred to by the President. Prof. Foster remarked that the Government granted the sum of 4000*l*. a year for the cultivation of all branches of science, and it had been determined to make an application to the Committee which administered that 4000*l*. for a sum which should indicate how that Committee, representing not only the Royal Society, but all the scientific societies of this country, held in scientific esteem the proposed expedition. It was not so much the sum of money that would be obtained as a clear indication that that Antarctic expedition was an expedition of undoubted and great scientific value. He did trust, speaking on behalf of the Society, that the appeal which had been made by the President of the Royal Geographical Society might be responded to liberally. Prof. Rücker said he did not think too much stress could be laid on the fact that any connection with Germany was in this case of the very greatest importance; that observations which were taken simultaneously in different parts of the Antarctic regions would be worth far more than two sets of observations taken several years apart. It was a matter of the greatest importance that the two expeditions should go out at the same time and co-operate with one another in the sense that their observations should be carried out with a common object. Sir Joseph Hooker, Sir Erasmus Ommanney, and Sir Leopold McClintock also spoke in favour of the proposed expedition. Admiral Sir W. Wharton thought such an expedition would be best carried out under the auspices of the Admiralty, because it would be an expedition of great difficulty and would need strict discipline. But the Government had for the time being declined to afford their aid, and he was very much of opinion that a small expedition, which, he hoped, might be sent out by private aid, would be able to act as the pioneer of a larger expedition afterwards.

THE International Congress of Mathematicians will meet in Paris on August 6-12, 1900. The Mathematical Society of France has appointed committees of organisation, M. Poincaré being president of that concerned with scientific papers, and M. Darboux of that concerned with the other arrangements.

THE fiftieth anniversary of the death of Berzelius was celebrated at Stockholm, on October 7, by a memorial service, at which the King was present. In commemoration of this event a small volume, containing twenty letters exchanged between Berzelius and C. F. Schönbein in the years 1836-1847, edited by Prof. G. W. A. Kahlbaum, has been published by Benno Schwabe, Basel.

DR. CALMETTE, director of the Pasteur Institute at Lille, has been made an Officer of the Legion of Honour.

THE death is announced, at Rome, of Count Michele Stefano de Rossi, distinguished for his seismological work.

LETTERS recently received from Prof. A C. Haddon, who it will be remembered left England in March last with an exploring party, to continue his researches in the Torres Straits, report favourable progress of the work. The islanders are said to have been everywhere delighted with the phonograph; but misfortune early befell the party, in the miscarriage of a case containing their cinematograph films and Joly's colour-photography apparatus. We regret to add that Dr. Haddon has been the victim of two or three very mild attacks of fever, and that one of his companions has been more severely affected. The latest intelligence reports an improved state of health, and that they will be by now leaving for Bornea, with the exception of Dr. Rivers and Mr. Wilkin, who are expected to return to England before Christmas.

WE regret to see the announcement of the death, at the age of sixty-five, of the French electrical engineer, M. de Meritens, under distressing circumstances. The best-known invention made by M. de Meritens (remarks the *Engineer*) is his dynamo, and though one of the very first, if not the first dynamo of any practical value, it is still used at the present time, though only—to any extent, at least—for electric lighthouses. The dynamo is an alternating-current machine, and its field consists of permanent magnets. In efficiency it may fall short of machines of

ater type, but it has sterling merit, as is evidenced by the number of years it has been at work continuously, night after night, in the electrically-lit lighthouses of Great Britain, France, and other countries. The last in this country to be so fitted was that at St. Catherine's Point, in the Isle of Wight. This was in 1888. M. de Meritens' inventions did not by any means end here. In the early days of storage batteries he was to the front with an invention by which he sought to increase the surface of the plates immersed in the liquid by means of a plate of lead, so bent that pockets were formed in it, in which lead shot were placed. He also suggested many other forms of battery. M. de Meritens also invented a motor, and at one time turned his attention to electric welding, being the first to suggest using carbon for one pole and the metal to be welded for the other pole. He also attempted to improve on the original "candle" of Jablochkoff by utilising a third rod of carbon between the two outside rods, instead of the usual plaster of Paris or kaolin.

THE annual meeting of the Yorkshire Naturalists' Union has been postponed from Saturday, November 19, to December 17.

THE officers of the Botanical Society of America for the ensuing year are as follows:—President, Prof. L. M. Underwood; vice-president, Prof. B. L. Robinson; secretary, Prof. G. F. Atkinson.

DR. G. KLEBS has been appointed professor of botany and director of the Botanic Garden at Halle, and Dr. W. Schimper succeeds Klebs as professor of botany at the University of Basel. M. C. Sauvageau has been appointed professor of botany to the Faculty of Sciences at Dijon.

WE learn from the *American Naturalist* that the University of California has received from the Alaskan Commercial Company of San Francisco a large and valuable gift, consisting of the collections which the company has been accumulating for many years. The ethnological portion of the collection is especially rich, and is probably one of the best in existence. The collection also includes fossil remains of mammoth, and many skins and mounted specimens of mammals, birds, and invertebrates of the Alaskan region.

THE State of Hamburg has, according to the *Botanical Gazette*, just established, at Freihafen, a station for plant protection under the direction of Dr. C. Brick. The station will look after the introduction of injurious insects with the shipments of living plants from abroad, and its duties will include also the combating of plant diseases, the oversight of the schools of viticulture, and the inspection of vineyards and orchards in the Hamburg region, together with such questions as may arise in the prosecution of the work.

THE winter lecture season at the Imperial Institute opened on Monday with an illustrated lecture on "Trinidad, with some account of the recent hurricane in the West Indies," by Mr. Henry Caracciolo. The lectures are open to the public without payment, seats being reserved for Fellows of the Imperial Institute and their friends. The following are among the subjects of lectures before Christmas:—"The stalactite caves of New South Wales," by Mr. F. Lambert; "Gold-mining in Victoria," by Mr. E. Lidgey; "A national photographic record," by Sir J. Benjamin Stone, M.P.

A FEW particulars of Mr. Nikola Tesla's new method of electric power transmission are given in the current number of the *Electrical Review*. From the article it appears that the invention consists in transmitting electrical power without the employment of metallic line conductors, by taking advantage of the conductivity of the rarefied air existing in the upper regions of the earth's atmosphere. In order to make this practicable, special apparatus has been devised for the production and conversion of excessively high electrical pressure. Heretofore, it has been possible, by means of the apparatus at command, to produce only moderate electrical pressures, and even these, with considerable risks and difficulties. Mr. Tesla, however, claims that he has devised means whereby he is enabled to generate, with safety and ease, electrical pressures measured by hundreds of thousands, and even by millions of volts. He has also, during his investigations with such apparatus, discovered certain highly important and useful facts, which are said to render practicable his new system of transmitting electrical energy. Among these are the following: first, that with electrical pressures of the magnitude and character which he has been able to produce, the ordinary atmosphere becomes, in a measure, capable of serving as a true conductor for the transmission of the current; second, that the conductivity of the air increases so materially with the increase of electrical pressure and the degree of exhaustion, that it becomes possible to transmit, through even moderately rarefied strata of the atmosphere, electrical energy up to practically any amount and to any distance.

DR. C. LE NEVE FOSTER'S general report (Part iii.) and statistics relating to the output and value of the minerals raised in the United Kingdom, the amount and value of the metals produced, and the exports and imports of minerals, in 1897, has been published as a Blue Book. The following interesting facts are recorded in it. The output of coal last year was 202,129,931 tons, the highest hitherto recorded. The quantity of coal imported was no less than 37 million tons, and is likewise the highest on record. The output of iron ore reached 13¾ million tons last year. Aluminium and sodium appear in the report for the first time. It is pointed out that the production of alumina from alum clay or bauxite, and the extraction of the metal in the electric furnace, form a new branch of industry which was only started in the United Kingdom by the British Aluminium Company a short time ago. The alumina is prepared at works near Larne, County Antrim, and then despatched to Foyers in Inverness, where abundant water-power enables electricity to be generated cheaply. The Foyers installation is so far the largest water-power plant in the United Kingdom. The quantity of alumina extracted at the Larne works last year was 850 tons, value 15,300*l*., which produced 310 tons of aluminium, value 45,880*l*. With regard to sodium, the Aluminium Company, of Oldbury, near Birmingham, are practically the only makers of this metal in the United Kingdom. The quantity made last year was about 85 tons. At the present market price this output would be worth 12,750*l*. It is regretted that statistics concerning the quantities of magnesium and potassium are unobtainable.

THE total output of gold ore (auriferous quartz) in the United Kingdom in 1897 is given by Dr. Foster, in the report above referred to, as 4517 tons, the total value at the mines being 6282*l*. Turning to the ores of copper, lead, tin and zinc, Dr. Foster's tables do not present a satisfactory picture. Copper mining is a decaying industry. The output of lead ore is also declining: last year it was only 35,338 tons, being the smallest recorded during the last half-century. We only now produce one-half the amount of lead ore we did twenty-five years ago, and the same remark applies in the case of tin ore, while the values in both cases have decreased to one-fourth. The output of zinc ore, 19,278 tons, almost the same as it was in 1896, does not reach the average of the last quarter of a century. Of the so-called non-metallic minerals, clay, limestone, sandstone and slate are the most important, the value of the output in each case exceeding one million sterling. A new feature in the volume consists of

›unty summaries, showing by means of tables the output of ıch county. This will prove of great service to those who are ›ecially interested in the welfare of any particular county.

FROM Prof. Kr. Birkeland we have received a reprint of a ıper by him in the *Archives des Sciences physiques et ıturelles*, on the phenomena of attraction or "suction" of ıthodic rays by a magnetic pole. Since the author's previous ıper in 1896, the subject has been treated from a theoretical andpoint by Poincaré, whose views have been put to an ‹perimental test in a recently published paper by Wiedemann ıd Wehnelt. In the meantime Prof. Birkeland has made a ew series of experiments on the subject, and his present paper ɔt only affords a completion of Wiedemann and Wehnelt's ıvestigation, but furnishes a simple method for determining ıe relation existing between the velocity of the kathodic rays ıd the difference of potential (between anode and kathode) ıder which these rays are emitted.

MR. B. G. TEUBNER, of Leipzig, has commenced to bring ıt a new and important mathematical work in German, entled the "Encyclopaedia of the Mathematical Sciences." 'he object of the Encyclopaedia is to give in a concise form but ith the greatest possible completeness, and in a manner adapted ›r easy reference, all the newest results in both pure and pplied mathematics. It is also proposed to show by carefully-repared literary sketches, the historical development of mathe-hatical methods since the beginning of the century. The ıncyclopaedia will consist of six volumes, of about 3840 ages, of which the first will treat of Arithmetic and Algebra; ıe second, of Analysis; the third, of Geometry; the fourth nd fifth, of Applied Mathematics; and the sixth, volume of istorical and allied matter. In the detailed table of contents ıe absence of any reference (specific or indirect) to "Trigo-ometry" or "Circular Functions" is somewhat remarkable, eeing that even such a subsidiary subject as "Inversion" has a ʼhole section devoted to it under Geometry. The editors are Dr. H. Burkhardt (Zürich) and Dr. W. Franz Meyer (Königs-erg), and the work is being published under the auspices of he Imperial and Royal Academies of Munich and Vienna and he Royal Society of Göttingen. From the prospectus we learn hat "lengthy demonstrations will in general be omitted."

THE French Meteorological Office has recently issued its *Innales* for 1896, comprising three large quarto volumes. The rst volume, under the title of "Memoirs," contains a discussion y M. Fron of thunderstorms observed during the year, with harts showing their distribution for each day on which a storm ccurred. M. Moureau publishes the details of the magnetic bservations at Parc St. Maur, with a summary of the character-stics of the principal disturbances. These and the simultaneous ariations of earth currents are also shown by means of curves. 'here is an important work by M. Brillouin on contiguous rinds and clouds, in which the author studies the very compli-ated phenomena that may be produced in a region where two tmospheric strata mix together, and in which the amount of loud is unequal. M. Angot discusses the problem of the arometric measurement of heights, and has prepared new ables to facilitate the calculations. The attention of scientific ıen has been drawn to this question by the observations made uring recent international balloon ascents. A contribution to he rainfall of the region of the Upper Nile is made by M. de Iartonne. Monthly and yearly values are given for some forty tations, collected from various sources. There are also other apers of a minor character. Vol. ii. contains the results of bservations made at various stations. The colonial stations ave been considerably extended, especially in Africa, and some bservations are given for Timbuctoo, in the centre of that continent. Vol. iii. is devoted entirely to the discussion of rainfall observations; the number of stations included in the work exceeds two thousand.

IN connection with the journal *Photography*, silver and bronze medals are offered for the best sets of lantern slides relating to the subjects named in the following sections:—(1) The rivers of Great Britain; (2) the commercial ports of Great Britain; (3) the old churches of the United Kingdom; (4) British trees, plants, and flowers; (5) scenes among fishermen; (6) striking natural scenes in Great Britain (rocks, caves, trees, waterfalls, &c.). The competing slides should be in the hands of the editors by December 10. The object of the competition is to renew sets of similar slides which have for several years been circulated by *Photography*, without charge or fee, and have been largely used in schools for purposes of instruction.

TWO papers on the food of certain cuckoos and shrikes, based on investigations by Prof. F. E. L. Beal and Dr. S. D. Judd, are contained in *Bulletin* No. 9 of the Division of Biological Survey (U.S. Department of Agriculture). In the laboratory of the Biological Survey 109 stomachs of the yellow-billed cuckoo (*Coccyzus americanus*), and forty-six of the black-billed cuckoo (*C. erythrophthalmus*), taken between May and October, were examined. The results show that of the 155 stomachs of both species only one contained any vegetable food. It appears that the insect food of these birds consists of beetles, grasshoppers, cicadas, bugs, ants, wasps, flies, caterpillars, and spiders, of which grasshoppers and caterpillars constitute more than three-fourths. The great majority of the insects found in the stomachs were harmful kinds. It is a matter of common observation that cuckoos feed largely on caterpillars, and stomach investigations not only confirm this, but show that, unlike most other birds, they eat freely of hairy and bristly species. Nearly half of the food of the birds examined was found to be caterpillars. Considering the number of grasshoppers, locusts, and other insects that cuckoos eat, in addition to caterpillars, it is evident that from an economic point of view these birds are two most valuable species, and as they have not been convicted of doing any harm, they should be protected and encouraged in every possible way. Besides insects proper, Prof. Beal found a number of spiders in the stomachs he examined, most of them the long-legged kinds commonly known as "daddy longlegs" (*Phalangidae*). One stomach contained seven, the mass of tangled legs looking like a bunch of coarse hair. When we consider the disagreeable odour of these spiders, their long legs, and the fact that their bodies have the texture of sandpaper, we are again forcibly reminded that tastes differ. But the most remarkable thing which the birds examined had eaten was a small tree frog (*Hyla*). which had been swallowed whole!

DR. S. D. JUDD investigated the food of two species of shrikes, and the results are given in the *Bulletin* referred to in the foregoing note. One species, the loggerhead shrike (*Lanius ludovicianus et sub-spec.*) is a permanent resident of the United States; the other, the butcherbird (*Lanius borealis*), is a migrant from the north. From the investigation it appears that the food of the butcherbird and loggerhead, as shown by 155 stomachs collected during every month in the year, and in an area extending from California to the Atlantic coast, and from Saskatchewan to Florida, consists of invertebrates (mainly grasshoppers), birds, and mice. During the colder half of the year the butcherbird eats birds and mice to the extent of 60 per cent., and ekes out the rest of its food with insects. In the loggerhead's food, birds and mice amount to only 24 per cent. A table showing percentages of principal elements of food of the butcherbird and loggerhead indicates that the loggerhead's beneficial qualities

outweigh 4 to 1 its injurious ones. Instead of being persecuted the bird should, therefore, receive protection.

CORNWALL is to be congratulated upon the success of the efforts its Technical Instruction Committee are making for the benefit of fishermen, through Mr. J. T. Cunningham, the County lecturer on fishery subjects. The report of the executive committee for fisheries for the year 1897–98, is almost entirely devoted to a valuable statement by Mr. Cunningham on records of sea fishing and sea temperature, experiments on oyster culture and lobster rearing, fish and net curing, and other matters concerning the science and handicraft of sea fisheries. Among the interesting items referred to in his report, is the fact that at the beginning of every season male crabs are always more numerous in the pots than females. Their number increases gradually till May or June, when it gradually diminishes; while the number of females taken does not reach its maximum till June or July, and then they are twice as numerous as the males, and they usually continue to be more abundant than the males until the end of the season. On the other hand, practically the same number of male lobsters are caught as female. The observations of surface temperature, made in connection with these fisheries, are of great service in indicating the influence of temperature upon the number of fish taken in various months. With regard to lobster rearing, Mr. Cunningham reports that important and gratifying success has been obtained, and much precise knowledge has been gained concerning the particular details of treatment on which the life and death of the larvae depend. His observations have convinced him that the opinion that swimming lobster larvae in the sea capture and feed upon other swimming creatures, especially other small swimming crustaceans, is wrong. He holds that lobster larvae are, like the adults, carrion feeders, and are not in the habit of pursuing or capturing live food at all.

MESSRS. DUCKWORTH announce for publication "A Glossary of Botanical Terms," by Mr. B. Daydon Jackson; and a "Textbook of Agricultural Botany," by Mr. J. Percival.

MESSRS. J. M. DENT AND CO. announce that after the December number *Natural Science* will be published by Mr. Young J. Pentland, of Edinburgh, who has acquired all future rights.

MESSRS. W. WESLEY AND SON have just issued a new Catalogue (No. 132 of their Natural History and Scientific Book Circular), giving a descriptive and classified list of 1500 books and pamphlets on the natural history of Great Britain and Ireland. The arrangement of works under the names of the English counties, Wales, Scotland and Ireland, will be of service to collectors of local fauna and flora.

THE following new editions of works already reviewed in NATURE have been received:—The third edition of Prof. Grenville Cole's "Aids in Practical Geology" (London: Charles Griffin and Co.) The work has been completely revised and enlarged; many additions of practical service to the geologist have been made, and all important factors of geological progress since 1893, when the second edition appeared, have been taken into consideration.—Messrs. Slingo and Brookes's well-known volume on "Electrical Engineering for Electric Light Artisans and Students" has been published in a revised and enlarged edition by Messrs. Longmans, Green, and Co. The work now occupies 780 pages, and it provides students with sound information concerning direct and simple alternating currents, the machinery and apparatus connected therewith, and their most important applications.—The tenth edition of Mr. C. Haughton Gill's "Chemistry for Schools" (Edward Stanford) has been published. Dr. D. Hamilton Jackson is responsible for the revision of the book and the additions made to bring it into line with the new regulations in chemistry for the London University Matriculation Examination.—The second edition, revised and enlarged, of Dr. Lassar-Cohn's "Chemistry in Daily Life," translated by Mr. M. M. Pattison Muir, has been published by Messrs. H. Grevel and Co.

THE additions to the Zoological Society's Gardens during the past week include two Pumas (*Felis concolor*, ♂ ♀) from the Argentine Republic, presented by Mr. Ernest Gibson; a Hamster (*Cricetus frumentarius*), European, two Bennett's Wallabies (*Macropus bennetti*) from Tasmania, a Gentoo Penguin (*Pygosceles taeniatus*) from the Falkland Islands, a Gold Pheasant (*Thaumalea picta*, ♀) from China, two Elephantine Tortoises (*Testudo elephantina*) from the Aldabra Islands, deposited; two Japanese Deer (*Cervus sika*, ♂ ♂) from Japan, received in exchange; an Axis Deer (*Cervus axis*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE LEONIDS.—Unfortunately for observers in the neighbourhood of London, a fog more or less continuously hung over their heads on the nights of Sunday, Monday and Tuesday, and rendered observations of the expected meteor shower impossible. Observers at the Solar Physics Observatory, South Kensington, were only able to observe two or three meteors during these nights. One of special brilliance, on the night of Monday, at 10.48 G.M.T., shot across the sky from east to west, its paths extending at least 45 degrees. This was undoubtedly a fine Leonid; but its path could not be traced, as fog and cloud hid the stars from view.

Mr. R. H. Scott informs us that the meteorological reporter at Jersey (Mr Fisher, at St. Aubin's) has reported to the Meteorological Office that a meteor shower was observed there at 10 p.m. on Monday.

From a New York telegram, published in one of the daily papers, we gather that the shower was observed in America on the night of the 14th, but it did not attain the expected brilliancy. Prof. Young is said to describe the shower observed as faint, while at the Lick Observatory the meteors were said to be small and not marked by extraordinary brilliancy.

A GLOBE FOR METEOR OBSERVERS.—Every observer, who has plotted the trails of meteors on star charts, knows that errors of projection arise which are due to the difficulty of plotting accurately the whole length of the trail. If the points of beginning and end of the visible trail be mentally noted and marked off on a star chart, then the line joining these two points does not represent the actual trail of the meteor, in consequence of the fact that the path in the heavens is on a sphere, and that on the chart is on a plane. To avoid such discrepancies it is always better to use a celestial globe, when this difficulty is eliminated. The ordinary celestial globe is, however, not well adapted for recording meteor observations, as it must be illuminated from the outside by a lamp, as the observer is in the open air.

A globe arranged especially for use when such observations are being made, recently invented by M. Pietro Maffi, is described in the French journal *Cosmos*, and should be found very serviceable. It consists of a glass hollow sphere mounted on two vertical supports, and capable of adjustment as regards latitude. The outer surface is marked with the brighter stars of each constellation and the Milky Way, and there is also means of obtaining directly the right ascension and declination of any point on the globe. The inside contains two small electric lamps in connection with accumulators in the stand, so that the whole surface of the sphere with the constellations may be seen clearly. Directly a meteor is seen its path can be plotted, and when note is taken of its exact position a wet sponge is all that is necessary to erase it.

The globe and stand, as it appears in the illustration accompanying the article, seems rather elaborate: but there is apparently no reason why a more simple and cheaper form should not be made, for its use then would be more widely distributed.

EPHEMERIDES OF COMETS AND PLANETS.—Many readers of this column will be very glad to know that from the beginning of next year it will not be necessary to turn up back numbers of the *Astr. Nach.* to find the ephemerides of comets and planets for observational purposes. Prof. H. Kreutz tells us (*Astr. Nach.*, No. 3527) that he has been asked from several sides to supply this information separately; that is, in addition to that published in the numbers of that journal, and he has made the following arrangements. Those who are subscribers to that journal may, by paying an additional sum of ten marks yearly, obtain such information, provided that notice of such requirement is given directly, and applications are sufficient in number to indicate a decided want in this respect. We hope that many of our readers will think fit to take advantage of this very useful change.

We may mention that it would be a good opportunity for keeping to one system of publication, and that the Right Ascensions, for instance, might always be given in time, and not in degrees, as is often the case.

THE NEBULOUS REGION ROUND 37 CYGNI.—Although there may be countless nebulae in the heavens symmetrical in form, there are others which seem to have absolutely no sense of regularity. Such a nebulous region is that comprised between 20h. 51m. 24s. and 21h. 0m. 43s. in Right Ascension, and in Declination between $+42° 56'·5$ and $+44° 51'$ (epoch 1900). An excellent reproduction of the greater part of this region appears in *Knowledge* for November, and is taken from a fine negative obtained by Dr. Isaac Roberts in October 1896. A careful study of the photographic appearance of this large cosmical mass shows, as Dr. Roberts remarks, several indications of fission, as well as evidence of *loci* of vortical disturbance in different regions; but, for the main part, irregularity is the striking feature. In his description of this nebulous region, Dr. Roberts brings up the question of the connection between the stars apparently immersed in the nebulous mass and the nebula itself. In regular, such as spiral, nebulae, Dr. Roberts had previously come to the conclusion that many of the stars immersed are not stars, as we are generally acquainted with, but star-like condensations, the result of condensations in the nebula itself. In the irregular nebula in question, in which the whole surface area of this cloud of nebulosity is covered with stars, ranging from the ninth to the seventeenth magnitude, very few of the stars can be pronounced "as being actually involved in, and forming part of, the nebulosity." Dr. Roberts' evidence for assuming that those what he terms "apparently finished stars" are between us and the nebulosity is, in his own words, as follows:—"If the stars were beyond the nebulosity their photo-discs would on the negative appear less bright, and their margins be more or less nebulous; whereas only those stars which appear involved in the nebulosity present these appearances. Of course, it is a fair subject for argument that those nebulous stars which appear to be involved in the nebulosity are not so in reality, but seem thus because they are beyond it in our line of sight. But this argument is much weakened, if not entirely destroyed, when we find on examination of the negative that those faint, star-like condensations are not only nebulous themselves, but they follow the curvatures found in various parts of the nebulosity; thus we are driven to infer that the stars are the nearer bodies to us, and that the nebulosity lies beyond the stars."

WOLSINGHAM OBSERVATORY CIRCULAR, NO. 48.—Mr. T. E. Espin in this circular informs us that a star, magnitude 8·4, Type IV., not in B.D. was found on November 13 in Right Ascension 4h. 19m. 49s., Declination $+ 39° 32' (55)$. The star in the Andromeda Nebula was seen on November 10, closely following the nucleus. The one found in 1886 was preceding.

THE EXTRACTION OF NICKEL FROM ITS ORES BY THE MOND PROCESS.[1]

THE Mond process marked an entirely new departure in metallurgical practice and in the principles which had hitherto guided it. It depended on the remarkable property possessed by nickel of forming a volatile compound with carbon-monoxide, from which metallic nickel might be released if the gaseous compound was heated to 180° C.

The methods hitherto employed for extracting the metal from its ores involved concentrating the nickel either as a sulphide (matte or regulus), or as arsenide (speise), followed by either dry or wet treatment; and the metal had to be refined, mainly with a view to separate it from associated carbon.

In 1889 Dr. Ludwig Mond, in collaboration with Dr. Carl Langer, had been engaged upon a method for eliminating the carbon-monoxide from gases containing hydrogen. They had been guided by the observation that finely-divided nickel removed carbon from carbon-monoxide at a temperature of 350° C., converting it into carbon-dioxide, whereas the dissociation of carbon-monoxide by heat alone, according to Victor Meyer and Carl Langer, remained incomplete at the high temperature of 1690° C. The experiments were carried out in conjunction with Dr. Friedrich Quincke; finely-divided nickel, formed by reducing nickel oxide at 350° C. by hydrogen, being treated with pure carbon-monoxide in a glass tube at varying temperatures. The gas escaping from the apparatus was ignited, and while the tube containing the nickel was cooling, the flame became luminous, and increased in luminosity as the temperature sank below 100° C. Metallic spots were deposited on a cold plate of porcelain held in this luminous flame, and on heating the tube through which the gas was escaping a metallic mirror was obtained, while the luminosity of the flame disappeared. These metallic deposits were found to be pure nickel. Nickel carbonyl was then isolated in a liquid state, and it was possible to produce it with facility in any desired quantity. It could be readily distilled without decomposition, but on being heated to 150° C., the vapour was completely dissociated, pure carbon-monoxide being obtained and the nickel being deposited in a dense metallic film upon the sides of the vessel.

No other metals which were submitted to investigation showed indications of combining directly with carbon-monoxide except iron. The discovery that in a mixture of metals only nickel and iron would form volatile compounds with carbon-monoxide, and that they could, therefore, be separated from the other metals, induced Dr. Mond to arrange experiments with ores containing nickel, cobalt, iron and copper, such as "kupfer-nickel" and "pyrrhotine." The experiments afforded such promising results that apparatus of considerable size, though still within the limits of the resources of a laboratory, was set up, and in it several pounds of ore could be treated with carbon-monoxide. The principal nickel ores which were metallurgically treated contained the nickel in combination with arsenic and sulphur, besides other metals and gangue. These ores had first to be submitted to calcination, in order that the nickel might be present in the form of oxide, and to drive off, as far as practicable, the arsenic, sulphur, and other volatile bodies. The resulting oxide of nickel was treated with reducing gases, such as water-gas or producer-gas, in order to convert the oxide of nickel into finely divided metallic nickel, and the material containing it was cooled to about 50° C., and was treated with carbon-monoxide.

In 1892 an experimental plant on a large scale had been erected at Smethwick, near Birminghan. The process began with "Bessemerised" matte; it ended with the market product, commercial nickel. The Bessemerised matte proceeded to the first operation of dead roasting, after which the matte contained 35 per cent. of nickel, 42 per cent. of copper, and about 2 per cent. of iron. It then passed to the second operation for the extraction of part of the copper (about two-fifths) by sulphuric acid, the copper being sold as crystallised sulphate of copper. The residue from this process contained about 51 per cent. of nickel, and it passed to the third operation for reducing the nickel. Incidentally, the remaining copper was reduced to the metallic state, care being taken to avoid reducing the iron. This was effected in a tower provided with shelves, over which mechanical rabbles passed, the reducing agent being the hydrogen contained in water-gas. The temperature did not exceed 300° C., and should be kept lower when much iron was present. From this tower the ore was conveyed continuously to the fourth operation of volatilisation, in which part of the nickel was taken off by carbon-monoxide and formed the compound nickel carbonyl. The formation of this volatile compound was effected in a tower similar to the reducing tower, but the temperature was much lower, and did not exceed 100° C. From the volatiliser, the ore was returned

[1] Abstract of paper read at the Institution of Civil Engineers, on November 8, by Prof. W. C. Roberts-Austen, C.B., F.R.S.

to the reducer, and it continued to circulate between the reducing and the volatilising stages for a period which varied between seven days and fifteen days, until about 60 per cent. of the amount of nickel had been removed as nickel carbonyl. The residue from this operation, amounting to about one-third of the original calcined matte, and not differing much from it in composition, was returned to the first operation and naturally followed the same course as before. The nickel carbonyl produced in the fourth operation passed to a decomposer, which consisted either of a tower or a horizontal retort heated to a temperature of 180° C., so as to decompose the nickel carbonyl and release the nickel in the metallic form, either on thin sheets of iron or, preferably, on granules of ordinary commercial nickel. Carbon-monoxide was in turn also released, and was returned to the volatiliser for taking up a fresh charge of nickel. When the operation was in progress, the gaseous carbon-monoxide and the partially reduced oxide of nickel and copper continuously revolved in two separate circuits, which joined and crossed each other in the volatiliser. The commercial product contained 99·8 per cent. of nickel.

The author proceeded to a description of the working as he saw it in full operation in Smethwick a few months ago. The plant had been working for some time, and about 80 tons of nickel had already been extracted from different kinds of matte. The results were quite satisfactory, and pointed to the conclusion that the process was well able to compete with any other process in use for the production of metallic nickel.

The process would always occupy a prominent position in chemical history, and there appeared to be no reason why it should not play an important part in metallurgical practice. Its application in Canada to the great nickeliferous district of Sudbury would probably contribute to the development of the resources of the great Dominion.

NATURAL HISTORY NOTES FROM YUNNAN.[1]

I LEFT Mengtze in the end of January with a caravan of mules, some forty, carrying stores, &c. I had three mule-loads, *e.g.*, of silver. The journey here took eighteen days, rather easy stages. The country passed through was very varied. I was in good spirits, rode nearly all the way, and enjoyed the trip very much. I crossed three large rivers *en route* by pontoon and suspension bridges ; the latter very well made, of iron rods joined by rings at the ends, the best specimens I have seen of Chinese blacksmith's work. At these river crossings we reached low levels, about 1800 feet above the sea, and came into tropical vegetation, which I never find at all interesting. At Yuenchiang, on the Red River, the ugly-looking shrub *Calotropis gigantea* was in flower, and there was a great display of the tree-cotton, *Bombax*, in flower, without any leaves, looking like an artificial candelabrum affair more than a living tree. These and some *Areca* palms were the only things of note. At the higher levels vegetation was at a dead point and I collected very little, one or two species of *Clematis*, two Rhododendrons : the very curious *Scolopendrium Delavayi*, which I had never seen before, I found one day on a shady bank where I stopped for tiffin. I also found, at the same place, two plants of *Abutilon sinense*, which had been sent by me from Ichang, and an *Antrophyum*, which may be new. I also came across *Lonicera Bournei* in flower ; it is of no value as an ornamental plant. There was very little forest until after Talang, when we passed one or two days through almost continuous pine forest, varied here and there by little woods of evergreen oaks. Here, rather to my surprise, I learned that the peacock exists in the wild state, and it is quite common in the forest south of Szemao. These pine forests had not a plant in flower amongst them. I noticed, however, two little woods made up of an *Abies*, new to me, but I only found one cone. However, I am not pretending now to give any account of the trip botanically, as it would require too much time to get my notes in order at the moment. On the eighteen days I may have collected about thirty plants in flower. At one or two places I might have done a lot of collecting if I could have stayed for a day or two, but I was travelling on official business, and could not tarry.

The main interest of the route was the aborigines, or non-Chinese races. Chinese here and there dwell on the little tracts of good land which are found in the high-lying valleys and plains of the plateau, and I passed through five or six largish towns mainly peopled by Chinese. But the larger part of the population was made up of aborigines. Whether the ethnology of this part of the world will ever be satisfactorily explained is doubtful. There seems to be the same variety in the human being as exists in the vegetable world in the same region, and there is a strange blending of races of Chinese, Malay, Negrito, perhaps even Caucasian here.

The greatly increased interest in China at home will, I hope, give a stimulus to the study of the history of the social evolution of the Chinese, which is calculated to bring out many important lessons for ourselves. There have been, as it were, two parallel developments of the human race, one on the west of Europe-Asia, the other on the east side, very little dependent on each other. At the start, the Chinese seem to have been fairly equal to the Westerners ; and even in the middle ages, judging from the way in which mediaeval travellers wrote, Chinese civilisation was quite as good as that of Europe. The decay of manly spirit, brought about by the idea that war is immoral, the low position of woman, the absence of an hereditary aristocracy holding up ideas of honour and probity and constantly acting as a check on philistinism, the government by officials selected by competitive examination in ancient classics and trivialities akin to Latin verse, all these causes must have been acting disastrously to have brought an intelligent race into such a low position.

There is a good deal of wooded country at no great distance from Szemao, and the mountains run up to nearly 6000 feet, but there is an absence of the sharp and precipitous kind of mountain and valley, and the flora in consequence is very uniform and not nearly so interesting as Mengtze nor so rich in species. Hills clad with pine and oak are almost barren in interesting plants, and I haven't come on any of those dark ravines and steep wooded cliffs which are the joy of the botanical collector. There is a great absence (perhaps the autumn will make a better show) so far of ferns and herbaceous plants. What one collects is mainly trees and shrubs and climbers. There is a fair number of epiphytic orchids. The common plants are not the common plants of Mengtze, in fact the two floras are very different. Szemao will possibly turn out very like the Shan country where Sir Henry Collett collected, and Indian forms not hitherto recorded from China are frequent enough. One curious thing occurs here as well as at Mengtze, *i.e.* the occurrence of two or three species of the same genus in precisely the same locality and often flowering at the same time.

The woods near Szemao are full of birds, and the notes are exquisite, and to be heard in perfection in these days of showery weather, for the rainy season has begun. When the sun gets out the cicadas start such a racket that one can hear nothing else. I have not told you of the jungle-fowl ; this is, I believe, *Gallus bankiva*, the original form of the farmyard fowl. They are very common in the forests and woods here, and are simply gorgeous. They are glorified bantams, the colours having a brilliancy that seems abated in the domesticated kind. They crow and cackle and behave in the woods just as a farmyard fowl would do, only they are a little shyer of man. Occasionally one sees a flying-squirrel, a big black one, sailing in the air from tree to tree, and I saw the other day what I thought was a calf ; it turned out to be a red-coloured deer, which speedily bolted with an upturned tail, white beneath like a rabbit's. It is very hard to believe that this particular deer, which only occurs, so far as I know, one or two together, never a herd, derives much advantage in life from this white-signal tail.

In many of the Mengtze and Szemao trees and shrubs the flowers occur on the branches below the leaves, and not on the peripheral surface of the tree, as in ordinary cases. Many lianas have this peculiarity. These are all forest plants, and I think the explanation is that in forests there are two surfaces open to insect-visitors, the top of the forest and the bottom. Some trees and shrubs and climbers cannot get to the top, so they have their flowers at the bottom. But of course this explanation is only a guess. There is no time for me to make any observations of the kind necessary ; if one could spend six months on end in a forest, one could observe, measure, &c. The *Mucuna sempervirens* of Ichang was a splendid example of this peculiarity. There was in one specimen a dense wall of foliage climbing over trees, interlaced with them, &c., nearly 200 feet by 100 feet, while the main trunk of the climber close to the ground was covered with

[1] Abridged from a letter to Mr. Thiselton-Dyer, from Dr. Augustus Henry, published in the Kew *Bulletin* for November (No. 143).

flowers which were easily visited by thousands of insects of all kinds.

There is quite a little group of shrubs which occur on the banks of rivers (and often in beds of streamlets) that overflow. These shrubs are submerged often and are not hurt. These *fluviatile* shrubs have a certain facies, very difficult to describe. There must be thirty or forty species of them in the Yunnan river valleys. These shrubs do not occur elsewhere than on banks or in the beds of streams. The last one I have found is a very fine species of *Ficus*. This class of shrub would be a nice enough problem for some one to work out.

I hope you will try and get a young Cambridge or Oxford botanist to come to this part of the world, do some naturalist work, and collect seeds and live plants for cultivation. China is a very easy country to travel in, and expenses of travelling are not heavy. The mountainous regions of Yunnan and Szechwan are very healthy besides.

TECHNICAL INSTITUTIONS IN ENGLAND.

THE current number of the *Record* of Technical and Secondary Education contains some encouraging statistics with regard to the establishment, extension, and adaptation of permanent technical schools and institutions in England since the passing of the Technical Instruction Act, 1889. The primary object of the inquiry (the results of which are now published) was to ascertain the amount of money sunk in buildings for technical education by local authorities, but some valuable information regarding certain details of organisation was obtained at the same time, and has been incorporated in the article. The statistics do not take into consideration either higher grade schools or schools governed by schemes under the Endowed Schools Acts and other secondary schools; but they refer to all the various types of permanent technical institutions, and, consequently, there are included domestic economy schools, agricultural and horticultural schools and colleges, farm schools, and dairy schools. It was intended to take in university colleges so far as they included technical or agricultural departments, but it is stated that as these institutions are largely non-local in character, supplying certain educational requirements in large areas by reason of the financial assistance of local authorities, they have been excluded. The following summary, given by the *Record*, shows the developments which have taken place, but, as has been mentioned, it only partly represents the progress made since 1889, as it does not take into consideration secondary schools serving the purpose of technical institutes.

The figures which appear under the head of "counties" refer to those institutions which have been directly established, and are being exclusively maintained, by County Councils.

(1) NUMBER OF MUNICIPAL SCHOOLS EXISTING OR IN COURSE OF ESTABLISHMENT:—

	Schools.
(*a*) In 47 county boroughs ...	71
(*b*) In 130 non-county boroughs and urban districts	132
(*c*) In 30 counties ...	36
Total number of municipal schools in England	239

This number does not include—(1) those voluntary technical schools which will probably become municipal institutions in the near future, viz. the schools in three county boroughs and three non-county boroughs and urban districts; (2) the municipal classes, held in rented premises, in 29 non-county boroughs and urban districts.

(2) INCREASE IN ANNUAL LOCAL CONTRIBUTIONS FROM THE RATES:—

	Amount voted in 1895-6 £	Amount voted in 1897-8 £	Increase in Rate-aid. £
(*a*) In 15 county boroughs	7,488	17,429	9,941
(*b*) In 70 non-county boroughs and urban districts	6,791	15,960	9,169
In 85 localities	£14,279	£33,389	£19,110

These figures are exclusive of—(1) those relating to Sheffield, where an additional sum of 1000*l.* will be raised by rate during the current year; (2) a total sum of 29,777*l.*, which has been voted from the general rate funds of urban authorities, and applied entirely to *capital* purposes.

(3) TECHNICAL SCHOOLS ESTABLISHED, EXTENDED, ADAPTED, &c., SINCE 1889:—

	County Boroughs.	Non-County Boroughs, &c.	Counties.	Totals.
Number of schools established...	42	89	32	163
" " in course of establishment	12	56	4	72
" " extended or adapted ...	14	46	—	60
" " transferred, purchased, or presented...	29	43	—	72

(4) PROVISION OF SITES FOR TECHNICAL SCHOOLS:—

	County Boroughs.	Non-County Boroughs, &c.	Totals.
(*a*) Sites *purchased* by the local authority ...	20	44	64
(*b*) Sites *given* by the local authority ...	8	17	25
(*c*) Sites *presented* by private individuals or Trustees ...	7	28	35

(*d*) Sums *involved* in the acquisition of sites { in 23 county boroughs ... £122,528; in 66 non-county boroughs and urban districts ... 55,214

Total for 89 localities £177,742

(5) CAPITAL EXPENDITURE UPON TECHNICAL SCHOOLS SINCE 1889:—

	Total sum involved. £	No. of localities.	No. of buildings
(*a*) County boroughs ...	1,351,193	50	69
(*b*) Non-county boroughs and urban districts	826,376	166	172
(*c*) Counties ...	112,853	22	26
Totals ...	2,290,422	238	267

To this sum an amount of 50,229*l.* should be added as representing the value of sites for technical schools presented by local authorities, Trustees, and private individuals in 18 localities, and included under section (4) of this summary; an aggregate amount of 2,340,651*l.* is thus shown as having been absorbed by the establishment of technical institutions in England from the year 1889. It should, however, be pointed out that the figures under (*c*) do not include the sums spent by the County Councils of Cambridgeshire, Lancashire, Warwickshire, and the East, North, and West Ridings of Yorkshire upon their municipal institutions.

Of the funds dealt with above, it is only possible to give the derivation of a sum of 1,854,036*l.*, which is apportioned among the different authorities as follows:—

	County Boroughs. £	Non-County Boroughs, &c. £	Counties. £	Totals. £
Loans ...	657,183	259,047	27,350	943,580
Donations and subscriptions, and Trust funds ...	309,716	178,436	13,567	501,719
Residue grant ...	167,642	92,366	71,936	331,944
Science and Art Department's grants	11,101	35,915	—	47,016
Lump sums from rate fund ...	18,036	11,741	—	29,777
	£1,163,678	577,505	112,853	1,854,036

In order the more easily to grasp the significance of these figures and to facilitate comparison, it may be well to present the following table of percentages:—

	County Boroughs. Per cent.	Non-County Boroughs, &c. Per cent.	Counties. Per cent.
Loans ...	$56\frac{1}{2}$	45	$24\frac{1}{4}$
Donations and subscriptions and Trust funds ...	$26\frac{3}{4}$	31	12
Residue grant ...	$14\frac{1}{4}$	16	$63\frac{3}{4}$
Science and Art Department's grants and lump sums from rate fund ...	$2\frac{1}{2}$	8	—
Per cent. ...	100	100	100

From this table it will be seen that, while the largest proportion of capital expenditure in the county and non-county boroughs, &c., is met by loans, the main source of supply of the County Councils is still the Residue grant. The extent of the assistance rendered by voluntary effort is also clearly indicated, as well as that given by the Science and Art Department; the smaller urban districts appear to have received the largest contributions from these two sources.

THE BRITISH ASSOCIATION.

BRISTOL MEETING.

SECTION K (BOTANY).

OPENING ADDRESS BY PROF. F. O. BOWER, SC. D., F.R.S., PRESIDENT OF THE SECTION.

SHORTLY before we met last year in the hospitable Dominion of Canada, two biologists, whose work relates to the questions I propose to discuss to-day, passed away. In both cases their services to science had received honourable recognition in this country. Johannes Japetus Smith Steenstrup, who had been for more than thirty years a foreign member of the Royal Society, died June 20, 1897, at the advanced age of eighty-four; Julius von Sachs, also a foreign member of the Royal Society, died May 29, 1897, aged sixty-five.

The former of these, a zoologist, was probably best known in this country for his work on "Alternation of Generations," a translation of which was published by the Ray Society in 1845. The title-page describes the phenomenon as "a peculiar form of fostering the young in the lower classes of animals." Botanists should remember that this term "alternation," which they often use in a sense peculiarly their own, was originally applied to the course of development in certain animals, by Chamisso in 1819. The first general statement of the subject from the zoological side was by Steenstrup in the work already named; even there no mention is made of such phenomena in plants, until the concluding paragraph, where there is an allusion in very general terms to the course of events in the life of seed-bearing plants. But when we remember that it was only in 1848 that Suminski discovered the antheridia and archegonia borne upon the prothallus of a Fern, we see plainly that Steenstrup could not have used the term "alternation" in the sense in which it is now generally applied to plants. The interest for us as botanists will therefore be that Steenstrup suggested in his work on alternation in animals how in the life of plants successive phases exist, and that these are comparable to those which he described in many animals.

The work of Sachs, on the other hand, has influenced every one of us. Some, including myself, have had the great advantage of his direct personal guidance; all must have derived pleasure as well as profit from his writings. I shall not here attempt any general summary of the achievements of this great man, for that has been done efficiently by the scientific press at large. I shall merely allude to one feature of his work, viz. the style of its presentment to the reader. He was always clear, usually concise. He was, in addition to his power as an investigator, a master with the pencil, as well as with the pen. It was this combination of qualities which made him the great text-book writer of his time. Never perhaps has a volume more fairly reflected the position of a science at the moment of its publication than did that of Sachs. It resembles the work of a snap-shot camera, and, like any instantaneous photograph of life in motion, it has fixed and perpetuated awkward positions. The morphological system of the time was stiff and unpromising; the text-book accurately depicted this, but it did not suggest or anticipate future developments; it did not bear the softened image of a longer exposure; it presents to us the angular attitude of a moment.

The powers of Sachs as a writer found their best scope in his "History of Botany," a work which will always retain its value as a masterly exposition of the results of very wide reading, arranged with a literary skill which is unfortunately rare among scientific men. I lay stress upon this power of Sachs as a writer, apart from his record as an investigator, because he was strong where so many of us are weak. The truth is that little effort is made by men of science to use a concise and transparent style; for the most part we write by the aid of such instincts as nature has given us; few cultivate composition. But it should, I think, be impressed upon the young aspirant that, when he writes, it is one of his first duties to consider his readers' convenience; he must use all endeavours to convey forcibly the result of his inquiry, but to make the least possible demand upon the patience of his readers. I should like to see certain papers selected as models of construction, to be studied as such by all candidates for our higher degrees; we should naturally include in the list those of the best masters of style in foreign languages, and among them would rank the late Julius von Sachs.

THREE PHASES OF MORPHOLOGICAL STUDY.

It will be in your memory that the Address of last year's Sectional President was largely devoted to branches of our science which touch the material and economic interests of man. It was pointed out to us how certain fungal diseases diminish agricultural profits to an extent which may be estimated in millions of pounds yearly. Beneficent microbes were also mentioned, such as those which govern the aroma and maturing of butter and cheese; these and many others, the study of which lies properly within the province of botany, affect not only the health, but, at the most varied points, the comfort and prosperity of mankind.

It is unnecessary for me to dwell further upon these matters, or to urge again the utilitarian argument for the proper support of botany. I propose, on the other hand, to invite your attention this morning to the Morphology of Plants. This is a department of science pure and simple. The results which it brings have not, and cannot be expected to have, any money value in the markets of the world. The present time is one of unusual bustle and change in morphology, consequent upon the discovery of new facts and the introduction of new methods. The development of the study may be divided into three periods, we ourselves standing upon the threshold of the third. The earliest phase was that of description and delineation of what might be observed of the mature form of plants; this includes the work of the herbalists and of the earlier systematists, who thus furnished the basis for classification. It is true that the mere description was enriched at times by comparisons made, but these often took a capricious form, as is shown by the many curious allusions which still survive in the nomenclature. Erasmus Darwin satirised the imaginative comparisons indulged in by early writers in his "Loves of the Plants"; an instance of this is seen in his lines referring to the legendary organism, half animal, half plant, suggested by the peculiar form of *Dicksonia* (*Cibotium*) *Barometz*:—

> "Cradled in snow and fann'd by arctic air
> Shines, gentle Barometz, thy golden hair.
> Rooted in earth each cloven hoof descends,
> And round and round her flexile neck she bends;
> Crops the gray coral moss, and hoary thyme,
> Or laps with rosy tongue the melting rime.
> Eyes with mute tenderness her distant dam,
> Or seems to bleat, a *Vegetable Lamb*."

The tendency to comparison thus already perceptible asserted itself strongly in the next phase of our study, to which it gave its character. And now the need arose for observing development; this was initiated by Schleiden, and carried to a triumphant climax by Hofmeister. Passing from the hands of these pre-Darwinian to those of post-Darwinian writers, the comparisons, while remaining virtually the same, received a new significance. Observers now pushed their inquiries into the details of anatomical structure and development, and in many cases attached an importance beyond what is justifiable to minute similarities or differences of cell-cleavage. Thus what might be called "cellular morphology" became a feature of the period. It has, however, been in a measure discredited by the excessive zeal of some of its votaries, who drew large conclusions from slight facts; a salient example of this is furnished by studies concerning segmentation of the ovum. But we must not assume that because it has been pursued indiscreetly, the study of segmentation is effete; there is still scope for valuable observation, which will bear a reasonable burden of argument; though conclusions from such a source must be compared with those derived from other data, and a due estimate of them must be made accordingly.

Morphology has lately passed to a third stage—that of experiment—with a view to ascertaining the effect of external agencies in determining form, and the limits of variability under varied circumstances. Development of itself shows only how a part originates; it does not demonstrate what it is, nor what it may become under special conditions. This new and growing phase of experimental morphology, together with comparison

from the point of view of descent, now tends to supersede the formal morphology of the second period, which in many minds implied or assumed ideal types or creative plans. It has become a general view that the facts of morphology are but the stereotyped facts of physiology, form being determined by function, but under the check of heredity. This third experimental phase of the study of plant form is directed, as it were, to the very setting of the types, before the stereotype plate is cast. We watch nature's compositor at work, but we also ascertain that the plate itself, after it is cast, is much more plastic than some of us had thought.

These three phases of morphological inquiry have naturally overlapped one another; we recognise, however, that first description, then formal comparison, and now experiment, have been the leading features in morphological investigation during these successive periods.

HOMOLOGY.

The ideal aimed at in the study of the morphology of plants is to trace their real relationships and mode of origin, on the basis of the widest observation—in short, to reconstruct the evolutionary tree. In order to make comparison possible, or at least manageable, a terminology is necessary, and this not only of the plants themselves, but also of their parts. We may for the moment leave on one side that summing up of morphological opinion represented by the systematic arrangement of plants in a taxonomic system. I propose to-day to discuss not the classification of plants, but the classification of the parts of plants, their grouping according to their *homology*. And here I use a word which is probably explained to every class of elementary students; it is one of those terms a meaning of which is indeed revealed to the babes of the science, while those who teach are not at one as to its definition. We need not enter now into the various opinions which have been held on this point, nor need we make any antiquarian research into the introduction or early use of the word *homology*: it will suffice to state that it was already firmly established in the science before views as to descent gave it any intelligible meaning. We speak of the homologies recognised by Hofmeister, but it should be remembered that their great discoverer did not put an evolutionary interpretation upon them. Sachs points out in his history how "the theory of descent had only to accept what genetic morphology had already brought to view." Nevertheless, much remained ingrained in the very texture of the science which was incompatible with evolutionary thought. This was so even in the text-book of Sachs itself. The categories of root, stem, leaf, and hair are there laid down, and the parts classed under these several heads were held to be *homologous*. In their definition all those characters which refer to function were put aside, the definitions relating to origin and relative position; the reproductive organs were grouped with the rest, with the result that these parts were described as bearing a varying morphological value. But this purely formal morphology is now dead; it long survived a mere passive belief in evolutionary views, but their active practice has strangled it. The first step towards emancipation was the recognition of sporangia as parts *sui generis*. Eichler, agreeing with Braun and Strasburger, found it "highly probable according to the theory of descent" that such a structure as the ovule has universally the same morphological dignity. It remained for Goebel to make the general statement that sporangia stand in a category by themselves, and are probably not the result of modification of any vegetative part. It was in this way that the phylogenetic factor was first asserted as bearing on a question of importance in the morphology of plants. Adherents of descent no longer passively accepted the direct results of investigation; they began actively to check and control the interpretation of them; but this position was not attained till more than twenty years after the publication of Darwin's "Origin of Species." Since then, however, views as to descent have taken an increasingly important place in the province of morphology, till at the present moment a far-reaching comparison of allied forms, assisted by experiment, is the most potent instrument in the hands of the morphologist.

But various writers admit in varying degree this factor of comparison as controlling other considerations. There is indeed a wide range of difference on this point. I will cite only two extreme views. On the one hand is the view of Strasburger, which he enunciated so early as 1872. The enthusiasm for evolution in the Jena school found its botanical expression in the aphorism, "The highest problem of morphology is to explain the form of plants, but this problem can only be solved genealogically." This statement is repeated in a more definite form in Strasburger's text-book: "Phylogeny is thus the only real basis for morphology."

At the other extreme is the method of physiological organography put forward by Sachs in his Lectures. I am aware that he subsequently modified his views; I merely quote the system which he propounded in 1882, as being the antithesis to that of Strasburger. For in the physiological organography descent is hardly taken into account at all; parts which are plainly of distinct origin by descent are classed together. This organography of Sachs, though introduced with all its author's charm of style, never convinced the botanical world, for it treated plants too much as the creatures of present circumstance. It may be taken as illustrating the extreme reactionary swing of the pendulum from the non-physiological attitude of the formal morphologists; a protest against the exclusion of function from the morphological arena. The protest was salutary, but its form was extravagant.

Let us now consider whither "phylogeny, as the only real basis of morphology," may lead us. Let us take as our provisional view that *homology* in the strictest sense implies repetition of individual parts, in successive generations, just as the hand of the child repeats in position and qualities the hand of the mother. Though among seed-bearing plants, for instance, this repetition may apply for the plant-body as a whole, it will be at once apparent that such repetition as regards the individual is found in comparatively few cases in plants. The continued embryology of all the higher forms, the indefinite number of the parts successively produced, and the variety in detail of their arrangement show that in the strictest sense repetition of individual parts cannot be traced. In a pan of seedlings of the Sunflower, raised from seed of the same parent, the cotyledons in all cases may be regarded as homologous in the strictest sense, as they correspond in origin, number, position, and form to like parts in the parent. In a similar way the first root of the seedling appears to be individually identical with the first root of the parent, or of any other seedling of the batch. In those plants in which a foot or suspensor is present occupying a constant position with regard to the parts of the embryo, it will not be doubted that within near lines of affinity the foot in any one specimen corresponds to that of any other. The exact repetition which is thus found to exist may be regarded as the most complete type of homology.

Starting from this repetition of individual parts in plants nearly related, there is a divergence by gradual steps in two directions: Firstly, in the individual plant, where the later formed parts may assume forms and positions which may even raise a question of their essential correspondence. Thus in the batch of Sunflower seedlings there may be a varying number of leaves, with varying transition from the decussate to the alternate arrangement, intervening between the cotyledons and the capitulum. As they vary in number and position these cannot in the strictest sense be accepted as individually comparable, each to each by descent—the lineal representatives of like individual parts in the parent. The lateral roots also, though all essentially similar, do not correspond each to each, either in number or in position.

Again, to go a step further, a Fern prothallus produces antheridia and archegonia; their number and position are not uniform; by conditions of culture we have them under control, and can induce antheridia only, or we can induce a formation of archegonia upon the upper surface, where they are usually absent. Plainly these cannot be held severally as the exact representatives of like individual parts in a previous generation. Another exceptional, but most interesting, case is that of *Aspidium anomalum*, Hk. and Arn., which Sir William Hooker remarks is possibly an abnormal form of *Aspidium* (Polyst.) *aculeatum*, Sw. In this Fern the sori, instead of being all on the lower surface, as in allied Ferns, are often upon the upper surface of the leaf. There is no sign of torsion to explain the anomaly, while the sori themselves present no structural peculiarity except that they are sometimes quite destitute of indusium. There has doubtless been a transfer of developmental capability from the usual position of the sori to the anomalous one. In case of such transfers as these we do not doubt that the parts in question are to be ranked as comparable to those in the normal position; we contemplate here,

as in the case of the Sunflower leaves, an essential correspondence, but not an individual repetition of the parts, and we learn that parts thus essentially corresponding to one another may be transferred to unusual positions.

Secondly, in plants more or less nearly related, those which are less akin may show so slight a similarity in detail that again questions of the essential correspondence of the parts may arise. Within nearer circles of affinity these questions will affect only the appendages of minor importance, which show less constancy of occurrence and arrangement, such as emergences and hairs; but in case of plants less nearly akin the degree of correspondence of the larger members may become a matter of debate. Take, for instance, the three great phyla of living Pteridophytes, the Ferns, Equiseta, and Lycopods. While the sporophyte as a whole in each of these may be accepted as homologous by descent with that of the others, the question as to the true correspondence by descent of the leaves must still be open for discussion. It is a tenable view that the three phyla arose separately from a non-foliar ancestry, and that the assumption of a foliar development, having in each case a different habit, and a different relation to the sporangia, led to the distinctiveness of the three stocks. Opinion on the point of homology by descent of the leaves of these Pteridophyta must at present remain in suspense; but the case is different with the leaf of Pteridophytes as compared with the leaf of Bryophytes: unless the whole morphological system of the time be in error, we shall be right in maintaining that these foliar developments have been distinct in origin from the first.

Now all the foliar parts above quoted would in a system of merely formal morphology fall into the category of "leaves." But if phylogeny be accepted as the only real basis of morphology, we must be prepared to split up the category based on mere time, place, and mode of origin, and to recognise in some cases repetition of individual parts; in others essential correspondence, but not individual repetition, owing sometimes to transfer of developmental capability; in other cases again, a possibility of distinct origin by descent not actually proved; and lastly a reasonable certainty of distinct origin. The practical question for the morphologist is, having recognised these facts for himself, how is the matter to be best made intelligible to others?

A reconsideration of the term "homology" will thus be necessary; is it to be applied equally to such parts as are connected by lineal descent, and also to those which we have good reason to believe have resulted from parallel development in quite distinct phyla? Or, to put a finer point upon our inquiry, are we to distinguish in any way the cases of "individual repetition" from those of "essential correspondence"? In the latter case I think no good end would be served at present by accentuating this distinction by terms: the steps of divergence are so slight and gradual. None the less should it be clearly borne in mind that comparisons of parts commonly ranked as homologous in the plant body are based on a less complete individual correspondence than that of parts usually compared in the animal body.

But the case is different in dealing with parallel developments, and some doubt arises whether parts which probably, or it may be certainly, have arisen by separate evolutionary sequence in distinct phyla are to be classed as homologous in the same sense as those directly related by descent. This question was long ago taken up on the zoological side by Prof. Ray Lankester, and it was shown that the old word "homology" covered two things recognised as distinct from the point of view of descent. He defined as *homogenous* "structures which are genetically related, in so far as they have a single representative in a common ancestor." On the other hand, "when identical or nearly similar forces or environments act on two or more parts of an organism which are exactly or nearly alike: further, if, instead of similar parts in the same organism, we suppose the same forces to act on parts in two organisms, which parts are exactly or nearly alike, and sometimes homogenetic, the resulting correspondences called forth in the several parts in the two organisms will be nearly or exactly alike. . . . I propose to call this kind of agreement *homóplasis* or homóplasy." Now this distinction of terms requires also to be observed in plant-morphology, and I am surprised that it has never yet been adopted by botanists, though we have long recognised cases of parallel development. I do not propose now to spend time in assigning these terms to familiar cases: but to take the examples already cited, the leaf of a Fern would be homoplastic, though not homogenetic with the leaf of a Moss; or, taking examples from plants more nearly akin, it would appear possible that the leaves of the three distinct phyla of living Pteridophytes show merely homoplasy not a true homogeny.

The successive foliage leaves of most plants are assumed in the individual to be the result of a mere repetition of development. But it is quite a possible view that in the plant-body (as is contemplated in the animal in those cases of "serial homology" which Lankester recognises as homoplastic) homoplasy may have had a place. We must inquire whether all those structures which we designate "leaves" have actually been the result of a development identical, or at least essentially similar as regards their origin in the race. The problem is, given a plant with numerous leaves of various form and function, to unravel the real story of their evolution. Two distinct factors may be contemplated as possibly occurring even in the individual, viz.:

(1) *Homogeny* of genetically related parts, with or without repetition of the parts formed.

(2) *Homoplasy*, an origin of two or more distinct categories of parts, not genetically related, on the same organism.

Working upon either of these, and thus complicating the problem by obliterating such distinctions as may have existed at first, may be the phenomenon of *metamorphosis*. This has lately received its evolutionary definition at the hands of Prof. Goebel, as restricted to those cases where there has been an obvious change of function. We see how change of function accounts for various forms of leaf in certain cases; but it does not follow that all leaf-forms on the same plant were so produced, by metamorphosis of a single original type.

The Lycopodineae are particularly interesting in illustration of this point. It appears probable that *Phylloglossum* is a more primitive type than other living Lycopods; it has two kinds of leaf, the protophylls borne in irregular number and arrangement on the protocorm, and the sporophylls of different form from these, and arranged regularly on the strobilus: commonly there are no intermediate steps between them. This condition in a plant, which on general grounds of comparison we believe to be primitive, is certainly interesting, and we shall ask whether the two types of leaf have not arisen by distinct evolutionary sequence? In the genus *Lycopodium* there are certain species, such as *L. Selago*, which show alternately sterile and fertile zones; examining the limits of the sterile zones, we find at the base of each leaf an atrophied sporangium, similar in position to that borne by a sporophyll. When we compare this condition with that of *Phylloglossum* it appears probable that the successive zones are the result of a metamorphosis of a strobilus, which had a continuous apical growth, and unlimited repetition of sporophylls, but that some of these suffered atrophy of their sporangia, with the correlative effect of a larger vegetative development. A differentiation of the strobilus thus results in the plant as we see it, a production of foliage leaves by sterilisation of sporophylls. Recognising this, some may suggest that the protophylls originated in the same way. It is possible that they did; but it is equally possible, and, in view of the peculiar case of *Phylloglossum*, I think more probable, that in these plants we have an example of homoplastic development of parts distinct as to descent, while the limits of the two still evident in *Phylloglossum* became obliterated in the more complex case of *Lycopodium*. The proof of the point will be difficult or even impossible, but the eyes of botanists should certainly be open to recognise such individual homoplasy, should it occur, and to inquire whether it has really had a place in plant-development.

Returning now to homoplastic development in distinct groups of plants, the morphology of the *foot* provides interesting material for comparison, and especially so since there is no question of repetition here; for the comparison is between parts of which only one appears on each individual plant.

The term foot has been applied to that part of the embryo in Pteridophyta which serves to connect it physiologically with the prothallus; the term has also been used for the base of the seta in Bryophytes. Parts performing a similar function, but not referable, as in other Phanerogams, to the metamorphosis of cotyledons, are also found in *Gnetum* and *Welwitschia*.

In the Bryophyta what is usually called the foot is no definitely specialised structure; it is merely the absorbent base of the seta. It would appear probable that in the Bryophyta a true homogeny holds in all cases, as the requirement for it will have been

uniform; and its basal position is also uniform, though some difference of detail does appear in the relation of this absorbing body to the first segmentation of the embryo.

In the Pteridophyta it is exceedingly difficult to be sure of the correspondence by descent of the foot in distinct types, and indeed it should not be assumed that a specialised absorbent organ was always present, though general surface-absorption will naturally have taken place in all archegoniate embryos; indeed the condition of some upright embryos is such that a foot would never have been described, were it not for comparison with other types. In *Equisetum*, *Isoetes*, *Botrychium*—all forms without a suspensor, and with an upright growing embryo—the hypobasal half of the embryo, with or without a root, is absorbent as in the Bryophyta, and is described as a foot; it is quite possible to see in them the continuation of a primitive absorbent organ. This may also be the case in the Marattiaceae, and it is specially noted by Campbell that "in *Marattia* all the superficial cells of the central region become enlarged and act as absorbent cells for the nourishment of the embryo." From such types we may imagine the more specialised foot of the Leptosporangiate Ferns to have been derived by a localisation of the absorbent function on one side only, which would be a natural consequence of the embryo taking the prone, in place of the vertical position.

A different course of events probably occurred in the Lycopodineæ. I am disposed to think that here the suspensor represents nothing more than a specialised part of the primitive absorbent organ; this seems to be indicated by the details as shown in Treub's figures of *L. cernuum* and *L. Phlegmaria*, in which the suspensor is continuous with the foot. But what is then the "foot" of *Selaginella*, which is quite apart from the suspensor, the root intervening? On this point I think we obtain light from *Welwitschia* and *Gnetum*, for in these we see an absorptive organ formed at a comparatively late period; and it corresponds in position and function, though not in time of origin or details of structure, with that of *Selaginella*. I conclude that the "foot" of *Selaginella* is probably a later formation, not comparable as regards descent either with the foot of *Lycopodium*, or with the "feeder" of *Welwitschia* or *Gnetum*. The latter are plainly of recent independent origin, as comparison shows, and their actual position is defined according to the position of the seed in germination. Probably, then, there is homoplasy in such cases, not true homogeny.

Similarly with such structures as the pinnae, stipules, indusium, corona, and still more so with such inconstant bodies as emergences and hairs; when we speak of the "homologies" of these parts it is rarely the *homogeny*, or identity by descent, which we mean to express; usually it is only *homoplasy*, a comparison of parts similar, it may be, in form and position, or even in development and function, though not shown to be comparable by descent.

ALTERNATION.

But the questions above discussed are mere matters of detail, compared with that great enigma of the alternation of generations in green plants, or of alternation at large. This is, after all, a question of degree of homology, not now of the parts only, but of the whole plant or "generation." How this greatest of all adaptations was really initiated, we cannot expect to bring to the point of demonstration; at best we can only venture opinions of probability. Still this discussion commands at present more widespread interest among botanists than any other in the sphere of plant morphology.

There was a time when the attempt was made to reduce all plants to one scheme as regards their life-cycle, a method which not only prevented elasticity of theory, but was responsible for some unfortunate comparisons. It was characteristic of the period when the text-book of Sachs reigned supreme; we find it there definitely laid down that "the doctrine of alternation has the object of reducing to one scheme the main phases of the life of all plants which bear sexual organs." But the controversy between Pringsheim and Celakovsky had, as one of its results, the recognition of various types of life-history, not of one scheme only. The tendency at present is towards the opposite extreme; the frequency of the parallel developments now recognised has led some to accept a comprehensive polyphyletic view as regards alternation, and wherever difficulties of comparison arise, to take refuge in the plausible suggestion that the organisms compared represent altogether distinct lines of descent. But the view which should be confidently upheld, is that even where this may actually be the case useful comparisons may yet be made; and that the method of progress within one phylum may illustrate the probable mode of progress in another. The green Algæ may thus throw light upon the probable origin of the sporogonium in the Bryophytes, though they may in no sense be in the line of their descent; the Bryophytes may suggest valuable ideas for the comparative study of the Pteridophytes, though they may not represent their actual ancestry.

It is the alternation as seen in these green plants that I propose to discuss. Writers have distinguished various types of alternation, including under the term divers modes of "alternation of shoots"; and it should be remembered that this was the original sense of the word alternation as applied by Steenstrup. But gradually the issue in the case of green plants has been simplified, and the question now centres round that alternation of phases which some of us describe as "antithetic," while others believe the phases to be really "homologous" as regards their origin.

Briefly put, the question is, How was the first start made? Has the neutral generation or sporophyte been the result of change of any other part of the sexual generation than the zygote itself? If so, the alternation is of *homologous* generations; if not, then the alternation is what is styled *antithetic*. The whole discussion is like a purely historical inquiry, but with the minimum of documentary evidence; for on this point the fossils give scanty help. In the absence of more direct evidence we are thrown back on other aguments, such as those based on comparison of normal specimens, and secondly upon the study of abnormalities. I shall not attempt to treat the matter exhaustively; it will, however, be necessary for me to deal with certain points in the discussion which were raised in the able address of Prof. Scott at Liverpool. He there restated Pringsheim's view of homologous alternation as against the antithetic. I propose now to consider three matters which I think are most material to the discussion, viz. (1) the bearing of the Algae and certain Fungi on the question; (2) the comparison from the Bryophyta; and (3) the argument from abnormalities.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—At the conjoint examination for entrance scholarships, just completed, the following awards have been made in Natural Science. At Pembroke College: Scholarship, G. H. Delf, Camberwell Grammar School, 40*l*. At Gonville and Caius College: Exhibition, M. M. L. Rittenberg, Tonbridge School, 30*l*. At Jesus College: Scholarship, J. Hewitt, Derby School, 40*l*. At Christ's College: Scholarship, C. H. B. Epps, City of London School, 40*l*.; exhibition, R. B. S. Sewell, Weymouth College, 30*l*. At St. John's College: Scholarship, G. C. E. Simpson, Mill Hill School, 60*l*.; Lupton and Hebblethwaite Exhibition (open *pro hac vice*), J. F. Hough, Mason University College, Birmingham; Johnson Exhibition (open *pro hac vice*), B. E. Mitchell, Brighton Grammar School. At Emmanuel College: Scholarship, H. U. B. Banham, Ipswich Grammar School, 40*l*.; exhibition, A. C. H. Rothera, Market Bosworth School, 30*l*. Clare College: Scholarships of 60*l*. to E. B. Bailey, Kendal Grammar School, and W. Cartwright, Middlesburgh Grammar School. Trinity College: Minor Scholarship of 75*l*. to C. S. Coles, University College, London; Exhibitions of 40*l*. to J. Frame, Mason College, Birmingham; C. W. Hutt, St. Paul's School, London; T. C. James, Aberystwyth University College; H. Lambert, Perse School, Cambridge.

Mr. F. G. Hopkins has been appointed University Lecturer in Chemical Physiology.

The degree of LL.D. will be conferred on Lord Kitchener of Khartoum on November 24.

The Clerk Maxwell Studentship in Experimental Physics will be vacant at the end of this term. Candidates, who must have worked in the Cavendish Laboratory, are to send their names to Prof. Thomson by December 9.

It is proposed that Advanced Students shall be admitted to Part II. of the Mechanical Sciences Tripos, and that for the B.A. degree they shall be required to attain the standard of the Second Class at least.

The General Board of Studies have proposed a scheme for the establishment of an Allen Research Studentship under the

bequest of the late A. W. G. Allen. The studentship is of the value of 250*l.*, is tenable for one year, and is open in alternate years to students proposing approved courses of research in (1) literary subjects, or (2) scientific subjects.

Seventy-five candidates have presented themselves during the past year for the Sanitary Science Examination. Of these thirty-nine were successful in obtaining the University diploma in Public Health.

The Engineering Laboratory Syndicate have lost no time in proposing a plan for the Hopkinson Memorial Building. The new wing will adjoin the present laboratory, and provide a lecture-room, three laboratory-rooms, and small rooms for students engaged in research. For the completion of the plan some 500*l.* will be required, in addition to the 5000*l.* generously given by Mrs. Hopkinson and her children. It is expected that the building will be ready for occupation in October 1899.

Mr. W. N. Shaw, F.R.S., was on November 10 appointed Assistant-Director of the Cavendish Laboratory for one year.

IN Berlin the flowers gathered in the town gardens are placed in the municipal schools for the purpose of furthering the study of botany. Arrangements have now been made by the London School Board, and will come into operation in April next, whereby a gardener will collect, pack, and forward to the schools of the Board botanical specimens and flowers, budding plants, leaves, &c., required for teaching botany or for object-lessons, or for the combination of drawing and object-lessons.

IT is expected (states the *Athenaeum*) that the London University Commission will commence its sittings this month. Mr. Bailey Saunders, the secretary, has been collecting information in Germany, especially concerning the organisation of higher commercial education, which will be made an important element in the newly constituted university, with the co-operation, it is hoped, of the London County Council. It is probable that the headquarters will be removed from Burlington Gardens. Christ's Hospital is talked of as the new site.

THE Calendar of the Imperial Tientsin University for the year 1897 has been received. The University was established towards the end of 1895, and its faculty includes several graduates of colleges in the United States. Mr. C. D. Tenney is the president, Prof. Oliver C. Clifford occupies the chair of chemistry and physics, Prof. E. G. Adams the chair of civil engineering, and Prof. N. F. Drake the chair of mining. Most of the tutors and teachers are natives of China. It is announced that last year his Excellency Li Chung-ta'ng showed his good will towards the University by a present of a 4-inch telescope, a phonograph, and several things for the physical laboratory.

ALDERMAN JOHN HOPKINSON, the members of his family, and near relatives, have offered to the Owens College, Manchester, in memory of the late Dr. John Hopkinson, a gift of 1000*l.*, to cover the expense of building the dynamo house connected with the new physical laboratory. It is hoped that by additional contributions from friends who desire to see a suitable memorial of Dr. Hopkinson in Owens College, where he was a student for three years, it may be possible to complete and equip the annexe containing in addition to the dynamo house a number of other rooms devoted to electrotechnics, and that the whole may be known as the "Dr. John Hopkinson Electrotechnical Laboratory."

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 11.—Mr. Shelford Bidwell, F.R.S., President, in the chair.—The discussion on Mr. Albert Campbell's paper on the magnetic fluxes in meters and other electrical instruments was resumed. Prof. Ayrton said he wished to offer some remarks on behalf of Mr. Mather and himself. The paper would, perhaps, have received more adequate discussion at the Institution of Electrical Engineers, for it was chiefly of a technical character. The importance of neutralising the effect of leads when using instruments with very weak fields, such as a Siemens' electro-dynamometer, should be emphasised. In instruments of the Kelvin-balance type where two opposed coils carry two opposed currents, the field spreads at the edges; the true "working" flux is not that directly between the coils. Mr. Campbell would have done better if he had used a long search coil wound round one of the swinging coils, forming part of a vertical cylinder. It would have been well also to have supplied some experimental proof that the astatic arrangement of the swinging coils of the Kelvin balance makes the instrument independent of the earth's field. The effect of the earth's field is of the order 0·2, so that with instruments of the Weston type, with a field of the order 1000, it was sometimes assumed, erroneously, that the readings were practically independent of the earth's H. Prof. Ayrton's own tests showed that by turning a Weston voltmeter towards different points of the compass, the errors in a particular case were far greater than might be predicted from the above ratio; the induction in the voltmeter pole-space, due to the earth's field, was much higher than 0·2; the earth's field was exaggerated by the iron pole-pieces; it was not necessary to suppose that the magnetism of the permanent magnet caused the variation. The error observed was about 0·2 per cent. in a horizontal field, and 0·8 per cent. when the field of the voltmeter was parallel to the earth's induction. Here the induction in the gap was 1200, and H = 0·2. In tests relating to the Ayrton and Perry magnifying-spring voltmeter, it was more important to know the B in the air-space *near* the iron than the B *within* the iron. Eddy currents might account for the extraordinary results obtained with the Shallenberger meter. Mr. J. H. Reeves described a method he had adopted for measuring the effect of stray fields upon ammeters and voltmeters. The instrument to be tested is first mounted on a stand and is brought under the influence of a large coil carrying a current. In this way, fields of known magnitude can be superimposed on the working field, throughout the range of the instrument, and the change of deflection due to them can be observed. From these known values, the working field can be deduced. For let the current in the solenoid of the instrument at any moment be A amperes, producing a corresponding unknown working field of magnetic force X. Then X is proportional to the solenoid current, as measured by the indications of the instrument. If a magnetic force x is superimposed on X, then x is measured by x X of A. If x is known, the working field X can be calculated from the change of deflection produced by the superposition. With Evershed ammeters, the field measured in this way was in one instrument 200, and in another 226; or about one-third of Mr. Campbell's figure (700) for the Evershed ammeter. Mr. Campbell's value of B did not represent the working field, but the field at the end of one of the fixed pieces of iron. Mr. Campbell, in reply, said he thought the theory of electrical instruments to be well within the limits of physics, and he had for that reason presented the paper to the Physical Society. The position chosen for the search coil in the Kelvin-balance tests may not have corresponded to the working flux, but it was near to the right position, and he had carefully specified the position chosen. His results as regards the Weston instrument differed from those of Prof. Ayrton, the errors he had observed for the particular ammeter used were under 0·1 per cent. The earth's field probably produced an effect different for different Weston instruments, according to the degree of saturation of the permanent magnet. In Mr. Campbell's tests, the Weston instrument did not have an iron case.—A paper by Prof. W. B. Morton, on the propagation of damped electrical oscillations along parallel wires, was then read by Prof. J. D. Everett. In a paper published in the *Phil. Mag.* for September 1898, Dr. E. H. Barton compared the attenuation of electrical waves in their passage along parallel wires, as experimentally determined by him, with the formula given by Mr. Heaviside in his theory of long waves. He finds close agreement as regards the effect of a terminal resistance, but large discrepancy in the case of the attenuation constant. Prof. Morton now investigates how far the results should be modified when it is supposed, as under actual conditions, that the oscillations propagated from the origin are damped, and that the circuit is not balanced, as in the ideal case of distortionless transmission. He finds (1) that the velocity of propagation is increased, while (2) the attenuation is increased, and (3) with infinite resistance between the ends of the wires, the waves are, as before, reflected completely with phase unchanged. As the resistance is diminished the amplitude of the reflected waves is decreased, and a phase-difference is introduced. For a certain value of the resistance the reflected amplitude is a minimum, and the phase-difference is $\pi/2$. When the resistance is zero there is again complete reflection, with the phase-difference π; *i.e.* the waves are reversed. The

result is that the reflection-factor for amplitude *seems* to pass continuously from (+1) to (−1) *without* passing through zero. Using the numbers given by Dr. Barton, it is found that the corrections to the simple theory are extremely small, so that in actual cases the damping may be ignored, and the circuit may be regarded as distortionless.—Mr. Oliver Heaviside (abstract of communication): Mr. Heaviside, using his own notation, exhibits mathematically the connection between the case investigated by Mr. Morton, of a wave-train arising from a damped source, and the standard case of an undamped source. The cause of the attenuating coefficient coming out twice as great in Dr. Barton's experimental conditions, as when the resistance is calculated by Lord Rayleigh's formula, is attributed to lack of correspondence between the experimental conditions and those of the ideal theory. For: (1) The external resistance, of unknown amount, is ignored. (2) It is not certainly to be expected that the formula in question is true for millions of vibrations per second. It may, however, be concluded from the experiments that the theory furnishes an approximation to the real resistance. (4) The magnetic vibrations to which the wires are subjected are not long-continued and undamped, as assumed by the formula. When a wave-train passes any point on a wire, its surface is subjected to an impulsion vibration lasting only a very minute fraction of a second; a vibration, moreover, which is very rapidly damped. So there is no definite resistance, and the resistance is greater than according to Lord Rayleigh's formula. (5) Perhaps, also, the terminal-reflections involved in Dr. Barton's calculations may introduce error.—The President proposed votes of thanks to the authors, and the meeting was adjourned until November 25.

Chemical Society, November 3.—Prof. Dewar, President, in the chair.—The following papers were read:—Determination of the equivalent of cyanogen, by G. Dean. By determining the quantity of potassium bromide which will react with a known weight of silver cyanide dissolved in nitric acid, the equivalent of cyanogen was ascertained to be 26·065; if the atomic weight of carbon be 12·01, that of nitrogen is 14·055.—The composition of American petroleum, by S. Young. The hydrocarbons boiling between 25° and 115° contained in American petroleum are isopentane, pentane, pentamethylene, isohexane, hexane, methylpentamethylene, benzene, isoheptane, heptane, methylhexamethylene and toluene.—The separation of normal and isoheptane from American petroleum, by F. E. Francis and S. Young. The presence of naphthenes in American petroleum renders it impossible to separate pure iso- and normal heptane from this source by fractional distillation; the impure heptane was brominated, and the heptyl bromides separated by distillation. The pure hydrocarbons were then isolated by reduction with a copper-zinc couple.—The boiling points and specific gravities of mixtures of benzene and normal hexane, by D. H. Jackson and S. Young. It is impossible to separate pure normal hexane by distilling mixtures of this hydrocarbon with benzene.—The action of fuming nitric acid on the paraffins and other hydrocarbons, by F. E. Francis and S. Young. The isoparaffins react readily with fuming nitric acid yielding nitro-compounds, but the normal paraffins are only very slowly attacked.—A composite sodium chlorate crystal in which the twin law is not followed, by W. J. Pope. In a composite crystal of sodium chlorate a four-fold axis of symmetry of the one individual was found to coincide in direction with a three-fold symmetry axis of the other; the plane (011) on the latter is parallel to the plane (010) upon the former.—Stereoisomeric bromonitro- and chloronitro-camphors, by T. M. Lowry. Nitric acid acts on bromo- or chloro-camphor with production of only one nitro-derivative in each case; on brominating or chlorinating nitrocamphor in alkaline solution, however, two stereoisomeric nitro-halogen derivatives are obtained in each case.—Camphoryloxime (camphonitrophenol), by T. M. Lowry. Camphonitrophenol is an oxime of camphoric anhydride.—The formation of ethereal salts of polycarboxylic acids, by S. Ruhemann and A. V. Cunnington.—Note on the action of light on platinum, gold and silver chlorides, by E. Sonstadt. During the action of light on wet silver chloride, a subchloride, hydrogen chloride and hydrogen peroxide are formed.—Methanetrisulphonic acid, by E. H. Bagnall. Fuming sulphuric acid acts upon diacetylbenzidine, its dichloro-derivative, α-acenaphthalide and acetanilide with formation of methanetrisulphonic acid, $CH(HSO_3)_3$.—The nutrition of yeast, by A. L. Stern. An increase of nutriment beyond a definite limit does not materially increase the amount of nitrogen assimilated by yeast, the percentage of nitrogen in the yeast, the weight of the yeast, or the amount of sugar fermented.—The yellow colouring matters of *Rhus cotinus* and *Rhus rhodanthea*. Part vi., by A. G. Perkin. Venetian sumach, the leaves of *R. cotinus*, contains myricetin; the leaves of *R. rhodanthea*, the yellow cedar of New South Wales, contain quercetin and gallotannic acid. The stems of both plants contain fisetin.—Colouring matters of the New Zealand dyewood "puriri," by A. G. Perkin. The New Zealand tree, "puriri" (*Vitex littoralis*) contains two colouring matters as glucosides; these are vitexin $C_{15}H_{14}O_7$ or $C_{17}H_{16}O_8$ and homovitexin $C_{16}H_{16}O_7$ or $C_{18}H_{18}O_8$. The former yields a penta- or hexa-acetyl derivative.—Cannabinol, by T. B. Wood, W. T. N. Spivey, and T. H. Easterfield. A number of derivatives of cannabinol are described.—Derivatives of hesperitin, by A. G. Perkin. Hesperitin combines with sodium or potassium acetate yielding crystalline compounds; the examination of these shows hesperitin to have the composition $C_{32}H_{28}O_{12}$. The azobenzene derivative and hexacetyl derivative of hesperitine have been prepared.

PARIS.

Academy of Sciences, November 7.—M. Wolf in the chair.—Preparation of lithium-ammonium, calcium-ammonium, and the amides of lithium and calcium, by M. Henri Moissan. At low temperatures lithium and calcium dissolve in liquid ammonia, forming deep blue solutions similar to those obtained from sodium and potassium. The lithium and calcium-ammoniums are more stable than the other analogous alkali compounds. Analyses showed that these substances are represented by the formulae $LiNH_3$ and $Ca(NH_3)_4$; both catch fire in contact with air at the ordinary temperature. —Remarks by M. Guntz relating to the preceding communication.—Preliminary note on the presence of free hydrogen in atmospheric air, by M. Armand Gautier. Air taken from the open sea or from mountains at high altitudes is very free from combustible hydrocarbons, traces of which are always present in the air of towns. The pure air, however, contains small quantities of free hydrogen amounting to about 11 to 18 c.c. per 100 litres, about one-half the carbonic acid present in the same air.—Comparison between the methods of Lagrange and Gauss for the resolution of entire numbers of indeterminate equations of the second degree, by M. de Jonquières.—Effects of the section of the nerves of the *sphincter ani* on the functions, physiological and anatomical properties of this muscle, and on the organism in general, by MM. S. Arloing and Edouard Chantre. If the muscle is completely isolated from the spinal column, real incontinence does not necessarily follow, the elasticity of the sphincter being sufficient to cause the expulsion of the faeces and urine.—On the genesis of epithelium, by MM. Armand Sabatier and Étienne de Rouville. It is generally admitted that epithelium is always capable of regenerating itself, and that it borrows nothing from the neighbouring tissues. This is contrary to the results obtained by the authors, who find that in many cases the underlying conjunctive tissue also takes an active part in this regeneration.—Observations on the sun, made at the Observatory of Lyons during the first quarter of 1898, by M. J. Guillaume.—Geodesic, magnetic, and astronomical surveys of Madagascar, by M. P. Colin.—On the convergence circle of some series, by M. Lean.—On stability, by M. J. Andrade.—Hertzian telegraphy without wires between the Eiffel Tower and the Pantheon, by M. E. Ducretet. The space over which the signals were transmitted was about four kilometres, and the clearness of the record showed that this distance could be considerably increased.—On the compound winding of alternators of constant voltage, by M. Maurice Leblanc. An alternator constructed on the principles here laid down was found to have a very constant voltage, even when changed rapidly from no load to full load. The residual magnetism is sufficient to render the dynamo self-exciting.—Contribution to the study of the boric ethers. Properties of triethyl borate, by M. H. Copaux. Chlorine gives trichlorethylether, $CH_2Cl_2.CHCl.O.C_2H_5$; sodium ethylate in absolute alcohol gives a precipitate of $BNa(OC_2H_5)_4$.—Combinations of phenyl-hydrazine with the halogen salts of the alkaline earth metals, by M. J. Moitessier. A description of the preparation of $CaBr_2.3H_2O.4C_6H_5N_2H_3$; and $SrI_2.4C_6H_5.N_2H_3$.—Estimation and detection of gelatine in gums and food substances, by M. A. Trillat. The aqueous solution of the gum is treated with formaldehyde. The gelatine is rendered insoluble.

and can be weighed after thorough washing by decantation. Test experiments gave results within one per cent.—The culture of some lower organisms in modified sea water, by MM. P. Duflocq and P. Lejonne. Several pathogenic organisms can become accustomed to grow in a medium containing sea water, also certain moulds (*Aspergillus niger*, *Muguet*, *Actinomyces*).—Action of the bacterium of sorbose on the aldehydic sugars, by M. Gabriel Bertrand. Arabinose, dextrose, and galactose are converted by the action of the sorbose bacteria into arabonic, gluconic, and galactonic acids respectively.—Instantaneous submarine photography, by M. Louis Boutan. In the earlier attempts at submarine photography, at least half an hour's exposure was required. The apparatus has now been so far improved that photographs have been taken of fish at distances at 1·5 to 2 metres from the lens, without any artificial light being necessary.—The post-larval stages of *Arenicolae*, by M. Pierre Fauvel.—The cephalic eyes in Lamellibranchs, by M. Paul Pelseneer.—On the Chamydomonadineae, by M. P. A. Dangeard.—On some new facts in the geology of the Dauphiny Alps, by M. W. Kilian.—On some lakes in the Eastern, Upper, and Lower Pyrenees, by MM. André Delebecque and Etienne Ritter.—Barometer movements on the meridian of the moon, by M. A Poincaré.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 17.

ROYAL SOCIETY, at 4.30.—Further Note on the Sensory Nerves of the Eye-Muscles: Prof. Sherrington, F.R.S.—Further Observations on the Effects of Partial Thyroidectomy: W. Edmunds.—Contributions to our Knowledge of the Formation, Storage, and Depletion of Carbohydrates in Monocotyledons: J. Parkin.—An Experiment in Search of a Directive Action of One Quartz Crystal on another: Prof. Poynting, F.R.S., and P. L. Gray.—The Electrical Conductivity and Luminosity of Flames containing Vaporised Salts: Prof. Smithells, H. M. Dawson, and H. A. Wilson.

LINNEAN SOCIETY, at 8.—On some Spiders from Chile and Peru, collected by Dr. Platte of Berlin: F. Pickard Cambridge.—The Botanical Results of a Journey into the Interior of Western Australia; with some Observations on the Nature and Relations of the Desert Flora, and on the Probable Origin of the Australian Flora as a whole: Spencer Le M. Moore.

CHEMICAL SOCIETY, at 8.—Preparation of Hyponitrite from Nitrite through Oxyamidosulphonate: Dr. E. Divers, F.R.S., and T. Haga.—(1) Absorption of Nitric Oxide in Gas Analysis; (2) Interaction of Nitric Oxide with Silver Nitrate; (3) Preparation of Pure Alkali Nitrites; (4) The Reduction of an Alkali Nitrite by an Alkali Metal; (5) Hyponitrites: their Preparation by Sodium or Potassium and Properties: Dr. E. Divers, F.R.S

FRIDAY, NOVEMBER 18.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Production of Liquid Air, and its Application to Chemical and other Industries: Cecil Lightfoot.

QUEKETT MICROSCOPICAL CLUB, at 8.

MONDAY, NOVEMBER 21.

SOCIETY OF ARTS, at 8.—Acetylene: Prof. Vivian B. Lewes.

IMPERIAL INSTITUTE, at 8.30.—The Stalactite Caves of New South Wales: Frederick Lambert.

TUESDAY, NOVEMBER 22.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Paper to be further discussed: Electrical Transmission of Power in Mining: William Beedie Esson.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—The Hill Tribes of the Central Indian Hills: their Ethnology, Customs, and Sociology (with Lantern Illustrations): Wm. Crooke.

WEDNESDAY, NOVEMBER 23.

SOCIETY OF ARTS, at 8.—Long Distance Transmission of Electric Power: Prof. George Forbes, F.R.S.

GEOLOGICAL SOCIETY, at 8.—Note on a Conglomerate near Melmerby, Cumberland: J. E. Marr, F.R.S.—Geology of the Great Central Railway—Rugby to Catesby: Beeby Thompson.—On the Remains of *Amia* from Oligocene Strata in the Isle of Wight: E. T. Newton, F.R.S.

THURSDAY, NOVEMBER 24.

ROYAL SOCIETY, at 4.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rotatory Converters: Prof. S. P. Thompson, F.R.S.

FRIDAY, NOVEMBER 25.

PHYSICAL SOCIETY, at 5.—On the Properties of Liquid Mixtures: R. A. Lehfeldt.—On certain Diffraction Fringes as applied to Micrometric Observations: L. N. G. Filon.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—La Cytologie Expérimentale: Dr. A. Labbé (Paris, Carré).—Publications of the British Fire Prevention Committee, Vol. 1 (1 Waterloo Place).—Allgemeine Biologie: Prof. M. Kassowitz, i. Band (Wien, Perles).—General Report on the Operations of the Survey of India Department during 1896-97 (Calcutta).—From Matter to Man: A. R. Dewar (Chapman).—Wild Animals in Captivity: A. D. Bartlett (Chapman).—Leçons de Chimie Physique: Prof. J. H. Van 't Hoff, translated by Prof. Corvisy, Part 1 (Paris, Hermann).—Traité Élémentaire de Mécanique Chimique: Prof. P. Duhem, Tome iii. (Paris, Hermann).—Through Arctic Lapland: C. Hyne (Black).—The Total Solar Eclipse, January 22, 1898 (Debra Dûn).—Traité d'Astronomie Stellaire: Prof. C. André, 1 Partie (Paris, Gauthier-Villars).—Practical Inorganic Chemistry for Advanced Students: C. Jones (Macmillan).—Birds of the British Isles: J. Duncan (Scott).—Aperçus de Taxinomie Générale: J. P. Durand (Paris, Alcan).—Life of Man on the High Alps; A. Mosso, translated by E. L. Kiesow (Unwin).

PAMPHLETS.—Review of Mineral Production in India for 1897 (Calcutta).—Replica di Krupp alla Protesta del Signor Bashforth: translated by F. Bashforth (Cambridge University Press).—Mines and Quarries: General Report and Statistics for 1897, Part 3, Output (Darling).—Temperature Entropy Chart; Captain Sankey (Rugby, Frost).—Sections and Thickness of the Lower Silurian Formations on West Canada Creek and in the Mohawk Valley: C. S. Prosser and E. R. Cumings (New York).—The Classification and Distribution of the Hamilton and Chemung Series of Central and Eastern New York: J. Hall and C. S. Prosser. Part 1 (New York).—Zwanzig Briefe g. z. Jöns Jakob Berzelius und Christian Friedrich Schönbein, 1836–1847, Herausgegeben von Prof. Kahlbaum (Basel, Schwabe).

SERIALS.—Morphologisches Jahrbuch, 26 Band, 2 Heft (Leipzig).—Scribner's Magazine, November (Low).—Observatory November (Taylor).—Encyklopaedie der Naturwissenschaften, Erste Abthg., 73 and 74 Liefg.; Dritte Abthg, 44 and 45 Liefg. (Breslau).—Engineering Magazine, November (222 Strand).—Himmel und Erde, November (Berlin),—Quarterly Journal of the Geological Society, November (Longmans).—American Naturalist, October (Ginn).—Astrophysical Journal, October (Chicago).—The Process Photogram, November (Dawbarn).—Transactions of the Edinburgh Field Naturalists' and Microscopical Society, Vol. iii. Part 7 (Blackwood).—American Journal of Science, November (New Haven).—Psychological Review, November (Macmillan).—American Journal of Mathematics, October (Baltimore)—Journal of the Chemical Society, November (Gurney)

CONTENTS.

THURSDAY, NOVEMBER 24, 1898.

EARLY MATHEMATICS.

Facsimile of the Rhind Mathematical Papyrus in the British Museum. With an Introduction by E. A. Wallis Budge, M.A., Litt.D., D.Lit., F.S.A., Keeper of the Egyptian and Assyrian Antiquities. 21 Plates. (Printed by Order of the Trustees.)

THE Rhind Mathematical Papyrus, a facsimile of which the Trustees of the British Museum have just issued, together with an introduction by Dr. Wallis Budge, is the document from which we gather most of what we know of the conception and use of mathematics by the ancient Egyptians. The papyrus does not contain a systematic treatise on mathematics, nor does it attempt to deal with the subject from a scientific standpoint. It consists rather of tables and sets of worked out problems, such as would constantly require to be solved by an Egyptian master-builder, land-owner, farmer or estate-agent. In consequence of the inundation, the area of an Egyptian farmer's holding was constantly changing in extent, so that the need of some practical method of measuring area was pressing. The farmer after harvest would need some plan for estimating the storage space required for his grain; the cattle-owner and employer of labour would constantly have to face problems connected with the distribution of fodder and provisions; the builder would require some method for estimating the angle of a pyramid to be erected upon a given base. Such problems as these were of every-day occurrence, and they forced the ancient Egyptian to employ his ingenuity in solving them. How far he was successful, and to what extent he proved himself a mathematician, we can gather from the Rhind Papyrus.

The papyrus consists of a roll, now broken in two pieces, which measure 10 feet 6 inches and 6 feet 9½ inches respectively. The text is written throughout in hieratic, but its actual date is not quite certain. Dr. Budge assigns it to a period not earlier than the beginning of the eighteenth dynasty, about 1700 B.C., but adds that the actual text goes back to an older period. It was probably a copy of a papyrus written in the Hyksos period, about 2000 B.C., by a scribe Ȧāh-mes, who states hat he himself copied an original work of the time of Ȧmen-em-hāt III., a king of the twelfth dynasty, about 2300 B.C.

Before treating of the contents of the papyrus it will be well to indicate briefly the limits in their knowledge of mathematics displayed by the ancient Egyptians, whose system was not so perfectly developed as that of the old Sumerian inhabitants of Babylonia. They approached their subject from the practical and not from the theoretical side; but in spite of numerous disadvantages in their system of notation, it must be admitted that they showed great ingenuity in dealing with the mathematical problems they attacked. With regard to integers the Egyptians used a decimal system of notation, but their system was inferior to the decimal system of the Arabs; for while in the Arabic notation each power of 10 is indicated by simply adding or removing a cipher, the Egyptians had a different name and symbol for each power; thus 1, 10, 100, 1000, 10,000, and 100,000 were each expressed by a different figure. This fact, however, did not prevent them from dealing without difficulty with very high numbers. In dealing with fractions, however, the case was different; here they experienced great difficulties, for, oddly enough, the Egyptian could only express divisions of unity. Any number, in fact, could be turned into a corresponding fraction by placing before it the word *re*, *e.g.* ½, ⅓, ¼, &c. By this system they could not express a fraction with a numerator greater than 1, though there was no limit to the divisor; in fact, in one of the sections on Plate *xf.* of this papyrus, the fraction 1/5432 occurs. There is one interesting exception, however, for they were able to express ⅔, but still as a division of unity, for they represented the fraction by a sign which may be rendered 1/1½. The Egyptians must have possessed multiplication tables, and those for the lower numbers were probably committed to memory; among these must have been included a table of 1/1½ values, for they could take ⅔ of a number by a single operation, and if they wished to take ⅓ of a number they halved its 1/1½ part. Besides adding and subtracting they were able, by means of their tables, without difficulty to halve and double, and to multiply and divide by ten and five. Multiplication by other numbers, however, they performed by repeated doubling and then adding; thus to multiply seven by six an Egyptian would double 7 = 14; he would then double the 14 = 28; and he would then add 14 to 28 = 42.

This brief sketch of the system of elementary Egyptian arithmetic will serve to explain the interesting arithmetical table which occupies the first six and a half plates of the Rhind Papyrus. This table was evidently worked out to help an Egyptian in his calculations with regard to fractions; it probably would not be committed to memory, but merely used for consultation like a modern table of logarithms. These six and a half plates contain the working out of a table expressing in simple fractions, with 1 for the numerator, the ratios of 2 to the odd numbers from 3 to 99, *i.e.* the fractions 2/3, 2/5, 2/7, &c. Plate i., for instance, gives the working out of these fractions from 2/3 to 2/15, from which we get the following table of results:—

2 divided by 3 = 1/1½
2 ,, ,, 5 = 1/3 + 1/15
2 ,, ,, 7 = 1/4 + 1/28
2 ,, ,, 9 = 1/6 + 1/18
2 ,, ,, 11 = 1/6 + 1/66
2 ,, ,, 13 = 1/8 + 1/52 + 1/104
2 ,, ,, 15 = 1/10 + 1/30

That this table was not due to the fancy of one scribe, but was a recognised table of values in general use, is proved by a fragment of papyrus found at Kahun in April 1889, on which part of the same table is written, and which shows the same values as the result of the division of two by the odd numbers from 3 to 21. The use of such a table is not at first sight very obvious, for if it is necessary to express 2/5 in fractions with 1 as the numerator, 1/5 + 1/5 is a simpler solution than 1/3 + 1/15. It has been suggested, however, that the Egyptians may have used the table for reducing fractions with higher numerators to fractions of unity; thus 5/11 might of course be expressed by the Egyptian as 1/11 + 1/11 + 1/11 + 1/11 + 1/11, but by means of the table a shorter

solution can be found, *i.e.* 5/11 = 1/11 + 2/11 + 2/11 = (by the table) 1/11 + 2/6 + 2/66 = (by their table of halves) 1/11 + 1/3 + 1/33.

On the right half of Plate xvi. is another somewhat similar but very much shorter table in a single column, giving some subdivisions of fractions which might prove useful in calculations, the results of course being expressed in divisions of unity, the table reading—

2/3 of 2/3 = 1/3 + 1/9
1/3 ,, 2/3 = 1/6 + 1/18
2/3 ,, 1/3 = 1/6 + 1/18
2/3 ,, 1/6 = 1/12 + 1/36
2/3 ,, 1/2 = 1/3

and so on. To the left of the table is a rule for finding 2/3 of a fraction, which reads as follows—

"To take 2/3 of a fraction. When it is said to thee, 'What is 2/3 of 1/5?' make thou its double and its six times. That is its 2/3. Thus is it to be done for every fraction that occurs."

The scribe evidently meant

$$2/3 \cdot 1/5 = 1/5 \times 2 + 1/5 \cdot 6 = 1/10 + 1/30$$

This general rule is exceedingly interesting, as it is the only one that occurs on the papyrus. In fact, the rest of the purely arithmetical part of the papyrus (Plates vii.–xii.) is thrown into the form of problems which are worked out with the object of being of practical use.

We have not space to do more than indicate the principal contents of the rest of the papyrus. Parts ii. and iii. (Plates xii.–xiv.) deal with the measurements of volume and area, in which given problems are worked out in estimating the amount of grain that can be stored in cylindrical and rectangular spaces of given proportions; in others the scribe has worked out the superficial area of fields of various shapes, the linear measurements of which are given; while diagrams are in some cases drawn of the shape of the fields. In this section of the work Dr. Budge remarks that the scribe has made a good many mistakes. Part iv. (Plate xv.) deals with the measurements of pyramids, of which six examples, with five figures, are given. The first on the page has the angle of the lower half of the southern stone pyramid at Dahshûr, four have the same angle as that of the second pyramid at Gîzeh, while the angle of the last is that of the pyramid at Mêdûm. Part v. (Plates xvi.–xx.) gives a worked out series of practical problems dealing with the reckoning of farm produce, the division of food among workmen, the cost of food for birds and animals, &c. They are all questions of practical interest, worked out, more or less, by rule of thumb. As Dr. Budge remarks in his Introduction to the Papyrus:—

"None of the examples or problems indicate that the Egyptians had any deep theoretical knowledge of arithmetic or geometry, but all of them show that they were very ready in making practical calculations."

Since the late Dr. Samuel Birch published an account of the contents of this document in the *Zeitschrift für Aegyptische Sprache* in 1868, the Rhind Papyrus has formed the subject of much discussion among both mathematicians and Egyptologists. A large body of students will, therefore, be grateful to the Trustees of the British Museum for placing in their hands the actual text of the papyrus in the form of a facsimile, which in beauty and accuracy of reproduction leaves nothing to be desired.

NEW ACCOUNT OF THE CHARACEÆ OF EUROPE.

Synopsis Characearum europearum. By Dr. Walter Migula. Pp. 176. Illustrated by woodcuts. (Leipzig, 1898.)

THIS is an abridgment of the author's large and elaborate work on the subject, which forms vol. v. of the new edition of "Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz." The latter is by far the most extensive and minute account of the European Characeæ which has yet appeared; but the present work, containing as it does almost all the illustrations, and most of the letter-press information in a condensed form, will, we think, be found the more useful for all ordinary purposes.

The first eighteen pages are taken up with an account of the structure of the Characeæ, with illustrations, and a chapter on collecting, examining, and preserving specimens. These are followed by a key to the genera and species. At the end there is a list of books and memoirs dealing with the Characeæ, also one of published sets of specimens.

The remainder of the book consists of a tolerably complete description of the genera and species, with figures of nearly all the latter. The arrangement followed is almost entirely that of Braun's "Fragmente"; but the anomalous species *Lychnothamnus stelliger* of Braun is elevated to a separate genus, *Tolypellopsis*, Migula (*Chara*, sect. *Tolypellopsis*, Leonh.), and *Chara rudis*, *C. horrida*, *C. crassicaulis*, and *C. delicatula*, which Braun regarded as sub-species, are treated as species. The author has gone to extreme lengths in the differentiation of varieties. For instance, *C. aspera* is credited with thirty-nine named forms, *C. fragilis* with thirty-seven, *C. crinita*, *C. ceratophylla*, *C. intermedia* and *C. contraria* have each more than twenty; while *C. fœtida* (excluding *C. crassicaulis*) has actually sixty-nine! The majority of these forms are of the author's own describing. From the larger book we learn that many of them are based on plants from single localities, and, judging by the citations, it is fair to suppose in some instances from individual specimens. Considering the extreme variation to which the vegetative parts of these plants are subject, it seems to us a great pity to multiply names by distinguishing every trivial form.

In the nomenclature of the species Dr. Migula has implicitly followed Braun, in several instances quite disregarding the accepted rules. It would, we think, have been as well to have mentioned some of the more generally known synonyms.

The book is, unfortunately, entirely in German. As it deals with the Characeæ of the whole of Europe, it would have been more widely appreciated had the key and the diagnoses of the genera and species, at least, been in Latin.

As we have remarked, the illustrations are the same as those in the larger work. They are on the whole decidedly good, especially those of the magnified portions of the plants, and several of the species are more completely figured than in any earlier book. Some of the representations of the entire plants are somewhat crude and inartistic, and that of *Nitella translucens* is very poor;

some, on the other hand, give a good idea of the habit of the plants.

Taking it altogether, the "Synopsis" is a very useful addition to the literature of the order, and it will be found a convenient handbook for reference.

H. and J. Groves.

OUR BOOK SHELF.

The Unconscious Mind. By A. T. Schofield, M.D., M.R.C.S. Pp. vii + 436. (London: Hodder and Stoughton, 1898.)

Dr. Schofield has set himself the task of familiarising the English public with the famous German theory of unconscious mental states. In his anxiety to let more accomplished psychologists speak for themselves he has, in many parts of his book, been content simply to reproduce the *ipsissima verba* of his authorities without criticism. Unfortunately he is himself scarcely psychologist enough to distinguish good authorities from bad, and trusts far too implicitly to the crudities and vagaries of such writers as Eduard von Hartmann. His work will hardly do much towards shaking the conviction of most English students of the science that "unconscious mind" is much such another phrase as "invisible colour" or "unextended body." Unconsciousness seems to mean very different things for him in the course of his argument. Instinct, he says, belongs to the "unconscious mind," because the animal executing the instinctive movement is unaware of its purpose. This seems quite unreasonable; the instinctive act is conscious enough in the sense of being attended both with sensation and with pleasure or pain; how then does the absence of knowledge of its biological value make it "unconscious"? Again we hear of "unconscious sensations," but they seem to mean no more than neural changes which would, under other conditions, be attended with consciousness. But surely it is obvious that it is one thing to say that if my attention had not been preoccupied a certain neural change would have resulted in a conscious sensation, and quite another to say that it has actually produced a sensation in my "unconscious mind." The unconscious execution of habitual mechanical processes is, of course, said to be presided over by "unconscious mind"; but where does the need of this undefined *tertium quid* come in? What is there, apart from the unscientific assumption as to the absolute heterogeneity of the psychical and physical, to prevent our saying quite simply that as a process becomes habitual and unconscious it ceases to be mental at all and becomes purely nervous? The believers in "unconscious mind" indeed profess to find it unthinkable that a combination of psychical elements should come to be replaced by a combination of physical elements, but they seem to have no better reason for their view than what Ebbinghaus well calls "this vulgar prejudice of the absolute distinction between mind and matter." It is probably not too much to say that Leibnitz's invention of the "petites perceptions" and Herbert's unlucky metaphor of the "threshold of consciousness" are responsible between them for an incalculable amount of psychological myth-making and confusion. Far the most valuable part of Dr. Schofield's book, the chapters in which he relates facts as to the therapeutic value of mental influences, is quite independent of his psychological theory.

A. E. Taylor.

Higher Arithmetic. By W. W. Beman and D. E. Smith. Pp. xvi + 193. (London: Ginn and Co., 1897.)

The book before us is for the service of teachers. It is not intended as a first course, but for those who have already had some experience, and wish to review and extend their knowledge.

The authors have adopted quite a new line of treatment, and instead of making the subject into a set of puzzles, as is so often done, they have introduced many improvements by showing how the subject is applied to every-day use. Thus we have a chapter on "Longitude and Time," and the reader is made acquainted with the relationship between them, together with the excellent system of universal time in use in the United States and nearly all over the world. Again, it is pointed out how a knowledge of arithmetic is applied to solve problems in elementary electricity. From the beginning to the end of the book the authors have made it their chief aim to point out the utility of the subject in its various applications. The book contains, besides an excellent list of definitions and etymologies arranged alphabetically, a great number of well chosen and appropriate examples.

The Story of Marco Polo. With Illustrations. Pp. xiv + 248. (London: John Murray, 1898.)

The preface is signed "Noah Brooks," and the little book is prepared specially for young readers. The plan is excellent, and well carried out. Selected extracts from Yule's "Book of Ser Marco Polo" are accompanied and woven together by a pleasantly written commentary, which seems to have been designed to interest the young people of the United States and the United Kingdom. Nothing could be better for the purpose. The extraordinary fidelity of many of Marco Polo's descriptions to fact is pointed out, and the incredulity with which they were received in a credulous age is duly dwelt on: a few of the more fanciful passages are also given, and the antiquity of these old stories noted. Probably many older people will see with surprise the minute exactness with which Marco Polo, six hundred years ago, described some of the most marvellous stock tricks of the modern Indian conjurers. The illustrations are not numerous, but very graceful and well selected. A map would have been a desirable addition.

H. R. M.

L'Art de Découvrir les sources et de les Capter. By E. S. Auscher. Pp. 278. (Paris: J. B. Baillière et Fils, 1899.)

Beginning with the physical properties of water, and dealing in order with the substances usually found dissolved in natural waters, the sources of these soluble materials, and the geological nature of the rocks through which subterranean waters percolate, the reader is introduced to the methods of water analysis in common use. The arrangement of strata and the characteristics of common rocks are explained with a view to making the circulation of underground waters easily understood. The third division of the volume, dealing with "La recherche des sources et des eaux souterraines," includes a chapter on "les signes extérieurs," which is only of doubtful scientific value, though many water-diviners doubtless receive great guidance from such considerations. Several of the illustrations are ingenious, and the book will be interesting to civil engineers who are concerned with questions of water supply.

Handbook of Insects Injurious to Orchard and Bush Fruits, with Means of Prevention and Remedy. By Eleanor A. Ormerod. Pp. x + 286; portrait and woodcuts. (London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd., 1898.)

Miss Ormerod has now added to her long and useful series of works on agricultural entomology by publishing a volume specially devoted to the insects and mites injurious to fruit. It is hardly necessary to say that the book is worked out in her usual careful manner, and freely illustrated. The principal fruits are arranged in alphabetical order, commencing with apple; and

under each, their insect enemies are enumerated. Fruit-growers who find their trees or bushes suffering from the attacks of insects, cannot do better than refer to this book to discover the cause and remedy. In a few touching lines, Miss Ormerod dedicates the book to the memory of her sister and co-worker, Miss Georgiana M. Ormerod, who was equally interested in entomological inquiries with herself. W. F. K.

Gas and Petroleum Engines. Translated and adapted from the French of Henry de Graffigny, and edited by A. G. Elliott, B.Sc. Pp. x + 140. (London: Whittaker and Co., 1898.)

A readable and instructive account of gas and petroleum engines is given in this little volume. The text can be easily followed by non-technical readers interested in gas and oil engines in use at the present time, and engineering students will find in the volume a good general survey of internal combustion motors. The subjects of the eight chapters are: the history of the gas engine, working principles of the gas engine, description of existing gas engines, carburetted air engine, petroleum engines, gas generating plant, engines for use with poor gases, and maintenance of gas and oil engines.

The Story of the Farm, and other Essays. By James Long. Pp. xv + 158. (London: *The Rural World* Publishing Company, 1898.)

The essays in this volume refer more to the economics than the science of agriculture. The author, who has had a long experience of agricultural public life, and has contributed many valuable manuals to the literature of farming, acknowledges that agriculturists fail to recognise the two great elementary requirements of the hour—technical instruction, to which alone farmers can look for their advancement in knowledge and success, and co-operation. The Countess of Warwick contributes an introduction to the volume, on "Women and the Future of Agriculture."

Publications of the British Fire Prevention Committee. Edited by Edwin O. Sachs. Vol. i. (London: British Fire Prevention Committee, 1898.)

Ten papers on methods of fire prevention and kindred subjects appear in this volume, which represents the first fruits of the establishment of the British Fire Prevention Committee. The papers call attention to the need for increased protection from fire by preventive measures, wider knowledge of methods of fire-combating, investigations of materials and forms of construction, and research into the causes of fires. They should thus be the means of imparting very useful knowledge, and obtaining active support for the movement for better preventive measures against fire, which led to the formation of the Committee under whose auspices this volume has been published.

The Story of the Cotton Plant. By F. Wilkinson, F.G.S. Pp. 199. (London: George Newnes, Ltd., 1898.)

This latest addition to the Library of Useful Stories, written by the director of the Textile School at Bolton, gives a clearly expressed and popular account of the chief cultivated species of the cotton plant, the pests and other injurious agents which molest them, and the methods of cultivation in different countries. The processes of picking, ginning and baling are described, and the plans for manipulating the cotton in carding, drawing, &c., dealt with. The early attempts at spinning are passed under review, and pave the way for an account of the modern spinning mule and the other processes in the spinning of cotton. The little volume, though perhaps not likely to be widely read, should be very popular in Lancashire.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Asymmetry and Vitalism.

Prof. Japp has so entirely changed his position that it is useless to attempt to follow him. I would desire, however, to correct misunderstandings into which he has fallen in respect of my contentions with reference to his original position.

I did not intend to suggest that life originated in a crystalline form; but merely that, as living things can now assimilate crystalline bodies, the first living organism may have originated in connection with and by utilising a crystal, and that the asymmetry of this original living organism may have been controlled by the accidental asymmetry of the original crystal.

Once life began, I presume it descended, as it does now, by section and so forth, and, as I cannot follow Prof. Japp's difficulties as to a particular asymmetrical system breeding the like, I cannot see how the intervention of intelligence is required for its propagation, any more than for the growth of a particular asymmetrical crystal, once it is started.

This preponderating influence of the parent entirely explains the other misunderstanding Prof. Japp has fallen into. I never suggested that the rotation of the sun, probably a very feeble cause, could make a seed, with its impressed asymmetry grow into a tree with a different asymmetry merely by bringing the seed from the northern to the southern hemisphere. All I suggested was, with reference to Prof. Japp's original position—namely, that at the *origin* of life the first living organism may have been given a particular asymmetry by its having been produced in one or other hemisphere. A cause which may have been quite sufficient to give this asymmetrical bias during the time of origination, may be quite inadequate to produce a change in the bias once it has been given.

Geo. Fras. FitzGerald.

Trinity College, Dublin, November 10.

Connection between Mânasarowar and Râkas-tâl.

Mr. Landor, in his account of his journey in Tibet, "In the Forbidden Land," claims to have disproved the connection between the lakes Râkas-tâl and Mânasarowar. The notice in Nature of November 3 speaks of the connection as being possibly open to doubt.

But it is not so. My brother, then Captain Henry Strachey, in the account of his visit to the lakes in 1846, published in the *Journal* of the Asiatic Society of Bengal, vol. xvii., gives full details on the subject. He crossed the stream that flows from Mânasarowar into Râkas-tâl at a point about a mile from the latter lake. He describes it as about a hundred feet wide and three feet deep, running rapidly from east to west in a well-defined channel. He did not visit the actual point at which this stream leaves Mânasarowar, but in 1849 I did so (see *R.G.S.J.*, vol. xxi.), and there is no more doubt about the fact than that the Thames runs past Richmond.

Mr. Landor, so far as his map and descriptions enable us to judge, and as the notice in Nature suggests, did not go far enough north between the lakes to admit of his ascertaining the facts bearing on the subject. Richard Strachey.

Lancaster Gate, November 12.

Arctic and Sub-Arctic Bees.

Of the wild bees of Alaska nothing is known, except that several species of humble-bees (*Bombus*) are common. Consequently, when Mr. Trevor Kincaid wrote me last year that he was going to Alaska, and would collect bees, I was expecting to see, on his return, quite a new bee-fauna. He collected carefully, and brought back a nice series, but all *Bombus!* No other genus was seen, although brightly-coloured flowers are quite numerous in Alaska. On the Pribilof Islands he found a fine new species of *Bombus*, which I named *B. Kincaidii*, but there was no other bee. I have written to Dr. W. H. Dall, to ask whether he ever saw any bees other than *Bombus* in Alaska. He replies that he collected there in 1868 four or five *Bombus*, and some wasps of the genera *Vespa* and *Pompilus*, but he has no record of other bees.

In Greenland, also, the bees are *Bombus*. Peary saw one quite at the northern end of that country. The one exception in America to the rule that only *Bombus* occupies the far north, so far as I remember, is the occurrence of *Osmia bucephala* at Great Slave Lake. In Europe and Siberia the same rule seems to hold, but doubtless several genera go further north than in America. *Andrena lapponica*, for example, is a decidedly northern type. The object of this note is to draw attention to the interesting question of the northern distribution of bees Those who have occasion to visit northern regions should collect what bees they can, noting the flowers they frequent, and in this way much valuable information may be gained. Probably some of your readers are already in a position to throw light upon the subject. T. D. A. COCKERELL.

Mesilla Park, New Mexico, U.S.A., Nov. 6.

Why Birds are not Killed by Eating Poisonous Fruit.

THERE is a great difference of opinion on this subject. While some maintain that birds do not eat fruits of this kind, others hold that they eat only the surrounding pulp, as of the berries of Taxus, which is perfectly harmless, whereas the seed is very poisonous; others, again, have maintained that they do not eat sufficient to be poisonous. The real fact is, I believe, that none of these statements are true, but that actually the birds eat largely of these berries, both pulp and seed, and that they very shortly afterwards eject the seeds and skins by the mouth, thus avoiding any poisonous action.

The first experience I had of this habit was in finding in September last an immense number of thrushes and missel-thrushes feeding on the berries of *Pyrus aucuparia* in Sutton Coldfield Park. At least a square mile of ground had every patch of grass covered with the ejected seeds and skins of these berries, all the pulp having disappeared, while the colour of the skins was as bright and fresh as when they were swallowed; showing that they could not have passed through the alimentary canal. Each of the pellets was flat and round, and about the size of a sixpence. The birds were incessantly flying to and fro betwixt the trees in the adjoining woods and the park. The excessive drought of last summer, by decreasing the supply of their ordinary food, was evidently the cause of their attacking the berries at this early period.

The next evidence I had of this being the explanation of their immunity from the effect of poisonous food was in October last, when I found on Boxhill, in company with Prof. Conwentz, of Dantzic, a number of similar pellets, but consisting entirely of the seeds and skins of yew berries; the former being as bright green, and the latter as scarlet as they were on the tree. In each of these pellets I counted twenty or more seeds.

The real difficulty in accepting this explanation is that, so far as I know, no one has actually seen the birds eject the seeds. Two friends of mine saw, the other day, what was very nearly the accomplishment of the process. A thrush was seated under a well fruited yew, and going through violent spasmodic contortions, the wings drooping on the ground; they thought it was ill, but it flew away strongly as if there was nothing the matter.

The idea that these birds only suck off the pulp from the berries is, I think, fallacious. Prof. Conwentz and I found under a large tree on Boxhill a great number of small fruit-bearing shoots, which had clearly been bitten off by squirrels; the ground was quite covered with seeds divested of their aril, and unbitten, though a few berries with the pulp bitten had been dropped by the squirrels. Mr. Morton Middleton tells me that at Dicksgrove, Co. Kerry, the yew-berries are largely eaten by thrushes, missel-thrushes, blackbirds, greenfinches, linnets, &c., and afterwards rejected, but he has not seen the birds in the act of doing this. He says, however, that turkeys, not being able to eject the seeds, are killed by them, although Rhind ("Vegetable Kingdom") says that these, as well as peacocks and fowls, eat them with impunity. Mr. Bennett (NATURE, October 13, 1898) asks for information as to the effect of birds and animals eating poisonous plants, and says that blackbirds eat the berries of *Atropa belladonna*. It does not appear that this was more than a supposition, neither is there any observation, so far as I am aware, as to what part of the berry, seeds or pulp, is poisonous. He says that mice eat the seeds of *Datura stramonium*. Here again we do not know whether they eat more than the kernel, which they would readily extract from the seed, as I have found them do in the case of *Ranunculus repens*, a small hole being bitten at the edge of the seed, while every kernel was extracted from the double-handfuls of seeds, which were collected in heaps.

"J. C." (NATURE, vol. lviii. p. 597, October 20, 1898) saw thrushes feeding freely on the berries of *Daphne mezereon*, an undoubtedly poisonous plant. In this instance there can be little question that they eject the seeds. He says they were so stupefied that they might apparently have been taken with the hand.

Mr. E. Langley, in the same number of NATURE, says that he saw blackbirds also eat these berries, but they did not appear the worse for a number of them.

Gilbert White ("History of Selborne, 1789, 329) speaks of milch-sows being killed by yew-berries, while "barrow-hogs and young sows" did not suffer. He attributes this result to the former being weak and hungry, and therefore eating a much larger quantity.

Prof. Tuson found (*Field*, 1877) that pheasants were killed by the leaves of yew, and there are several similar instances recorded since that date.

A. von Kerner made a number of experiments to show that seeds eaten by blackbirds, germinated in the following June; whilst those not so eaten, remained on the ground three or four years. O. Kirchner says that a species of Motacilla eats the berries; but this I regard as a doubtful statement. I have frequently seen them capture flies attracted by the fruit, but have never seen them touch the fruit itself. Every one is, of course, familar with the manner in which owls disgorge the fur and bones of mice and skulls of small birds, a habit which Mr. Harting tells me is shared by all the raptorial birds, as well as by shrikes, flycatchers, and rooks; and there are other facts alluded to by Sir Herbert Maxwell in his "Memories of the Months," and others of insects feeding on deadly poisons without any injury. The habit of ejecting the indigestible parts of their food by birds, seems to require further observation and experiment. JOHN LOWE.

Sun-spots and Air Temperature.

THE following comparison is, I think, instructive:—

Make out a table (from Greenwich data), in which each month since the beginning of 1841 is simply characterised as + or −, according as its mean temperature has been above the average (warm), or below it (cold).

Then, in each five-year group having a sun-spot maximum year central, count the warm and the cold months; and the same with five-year groups having a minimum central. We get these tables:—

Max. groups.	*a* Warm months.	*b* Cold months.	*a* − *b*
1846–50	38	22	+ 16
1858–62	32	28	+ 4
1868–72	34	26	+ 8
1882–86	33	27	+ 6
1892–96	35	25	+ 10
	172	128	+ 44

Min. groups.	*a* Warm months.	*b* Cold months.	*a* − *b*
1841–45	26	34	− 8
1854–58	30	30	0
1865–69	35	25	+ 10
1877–81	26	34	− 8
1888–92	17	43	− 26
	134	166	− 32

Thus, in each of the maximum groups, there is an excess of warm months; and taking the whole, an excess of 44 warm months. In most of the minimum groups, on the other hand, an excess of cold months; total excess, 32 months.

With regard to the exceptional case—1865–69—in the second table, it may be worth remarking that 1860–70 is one of Brückner's warm periods. It seems to me that a consideration of both those cycles—the sun-spot cycle of about 11 years, and Brückner's of about 35 years—furnishes the clue to a great deal of our weather. A. B. M.

On Keeping Marine Organisms Alive in Small Aquaria.

IN NATURE of November 10 (p. 44), a contrivance is mentioned by the use of which the sea-water in a small aquarium can be kept in motion. The same kind of apparatus has been employed during the winter 1897-98 in Kiel, for keeping Peridinea and Diatoms of the Plankton in a healthy condition. Prof. Geo. Karsten has described the apparatus used in the *Wissenschaft. Meeresuntersuch. der Kommiss. z. wissenschaft. Untersuch. d. deutsch. Meere in Kiel und der Biolog. Anstalt a. Helgoland*, vol. iii. part 2, March 1898, p. 8. In this case a clinostat-clockwork was used, and the plunger rose five times in three minutes. The bell-jar, serving as an aquarium, was very small, holding about 1·5 litre. Ceratium and Skeletonema got on very well, the same plants dying off rapidly on being kept in water at rest.

OTTO V. DARBISHIRE.

Owens College, Manchester.

THE NOVEMBER LEONIDS OF 1898.

VERY unfavourable weather was experienced all over the country at the middle of November, and the return of the Leonid meteors was very scantily observed. At many stations no observations whatever were possible between November 13 and 16, while at other places only one of these nights was partially clear. As a result of the bad atmospheric conditions, very few meteors have been recorded. But it seems certain, from a comparison of the fragmentary observations obtained at various places, that, apart from the unfavourable influence of the weather, the meteoric shower did not nearly answer expectation. In fact, the number of meteors visible appears to have scarcely exceeded the average number that may be counted on an ordinary mid-November night. It is true that the observations did not cover the whole of the three nights of November 14, 15 and 16, and were, moreover, effected in most cases under circumstances little calculated to ensure successful results. But making every allowance for the difficulties encountered, the feeble character of the shower is still significant, and proves that the earth in recently crossing the node of Tempel's comet of 1866, did not encounter the denser part of the meteoric stream, but a very attenuated region far in advance of the associated comet. Indeed, the recent display appears to have been scarcely richer than those of 1879 and 1888, when the comet was not a great distance from its aphelion. Of course, the real shower may have occurred in the daytime, but it would scarcely escape recognition in America or some other distant part, for observers all over the world are keenly alive to the attractions and the importance of the Leonid display, and have been on the alert to witness it.

Descriptions of the recent shower from the United States are not dissimilar to those from our own country. Of course, we cannot rely upon the exaggerated statements published in some of the American newspapers, or sent home by the New York correspondents of certain English journals. One of the latter, writing on November 15, says: "Astronomers throughout the United States watched the shower of Leonid meteors, which appeared between midnight and five o'clock this morning. Many of the meteors made brilliant flashes across the sky, and left fiery trains. One meteor in Orion lit up the entire city of New York at about one o'clock in the morning, and fell hissing, the sound indicating its close proximity." More trustworthy accounts from astronomical observers at the Lick Observatory, Mount Hamilton, the Princeton Observatory, and others at Richmond, Virginia, agree that the late display was a disappointing one, the meteors seen being neither numerous nor brilliant.

With regard to observations made in this country, the writer has received reports from London, Oxford, Bridport, Yeovil, Cardiff, Chester, Loughton (Essex), Cirencester, Stone (Staffs.), Leeds, Southport, Belfast, Dumfries, and several other places. A few quotations from these may perhaps be interesting:—

Belfast.—A watch was maintained on November 12 to 15h. 30m., but no Leonids observed. On the following night (13th), to the same time, six meteors were recorded, and of these three may have been Leonids. On November 14, the sky was overcast to 16h. 40m.; then it partly cleared; but there was a good deal of mist, and the stars shone very dimly. Between 16h. 40m. and 17h. 15m. the observer saw ten fine Leonids; but the sky became cloudy again, and observations were discontinued. The shower was regarded as a fairly strong one under the conditions, and the maximum appeared to be at about 17h.—W. H. Milligan.

Southport.—Observations were made at the Meteorological Observatory on November 14, 13h. 30m. to 17h. 30m., and the following were the hourly number of meteors (nearly all Leonids) noticed by one observer:—

h. m.		h. m.		
13 30	to	14 30	=	15 meteors.
14 30	to	15 30	=	10 ,,
15 30	to	16 30	=	3 ,,
16 30	to	17 30	=	2 ,,

The meteors were small, not one being brighter than a 1st mag. star. The scarcity of meteors, only five being seen between 15h. 30m. and 17h. 30m., is remarkable.—J. Baxendale.

Yeovil.—On November 14 the sky was clear, but only two or three meteors were remarked in the two hours between 13h. and 15h.—Rev. T. E. R. Phillips.

Cirencester.—Weather clear during the whole night of November 14, and only a little fog at low altitudes. Observations were made from a window facing E., between 11h. 45m. and 12h. 50m., but no meteors were seen. The sky seemed unaccountably light.—Miss E. Brown.

Gateshead. On November 13, between 10h. and 15h., the atmosphere was favourable, and observations were made at short intervals, but no meteors were seen.—Dr. A. W. Blacklock (*English Mechanic*).

Northants.—On November 14, from midnight to 15h., a watch was kept with results almost *nil.* The sky was, however, partially veiled with clouds through which only a few stars could be seen. There was a very brilliant meteoric flash at 13h. 55m.—F. H. Wright (*English Mechanic*).

Bristol.—On November 12 the clouds passed off at 15h., and the sky was watched intermittently until 17h. Only seven meteors were seen. There was no sign of radiation from Leo. At 16h. 4m. the sky was illuminated, probably by the outburst of a large meteor in a region of the heavens hidden to the observer. The nights of November 13 to 19 were all overcast, and no observations could be obtained.—W. F. D.

Chester.—On November 16, between 10h. and 13h., six plates were exposed for 30m. each, but no meteor trails were secured. The meteors appeared to be scarcer than on any ordinary night. At 12h. 8m. a Leonid of the apparent brightness of Mars was seen, and with the exception of a small, swift Perseid nothing else was recorded.—F. W. Longbottom.

The remainder of the reports are stories of failure in consequence of the weather. At many places a series of dense fogs occurred just at the important time. In spite of these drawbacks, however, the fact remains that at certain stations on November 15 a clear sky invited observation, but presented very few meteors. It is true that Mr. Milligan saw some brilliant ones in the hazy sky of November 14, 16h. 30m. to 17h. 15m., and that the observed maximum of the "shower" seems to have occurred at nearly the same time as last year. But the phenomenon, so far as it was observed, was quite of minor character, and observers who saw nothing what-

ever, owing to the weather, may take comfort in the reflection that they lost very little. Of course, further observations may come to hand from distant places where the stars shone and meteors fell. If so, we may possibly have to modify our present ideas; but from the materials now before us, we can only draw the following conclusions:—

(1) The state of the atmosphere generally was very unfavourable for the observation of meteors.

(2) The number of meteors which appeared was small, and never at any time formed a display of special richness.

(3) The earth was too far in advance of the cometary nucleus to encounter the denser region of the meteoric stream.

But the observations obtained this year, if of a negative character, and very discouraging from an observational point of view, will yet be important as affording evidence of the tenuity of that section forming the vanguard of the stream.

The meteoric observer, disappointed as he has been in 1897 and 1898, may yet look forward with every confidence to the brilliant displays which will mark the years 1899, 1900 and 1901. W. F. DENNING.

NOTES.

IT has already been announced that in connection with the Royal Society the Colonial Office has instituted a Commission to investigate the subject of tropical malaria. We are now informed that the medical officers selected for the work in Africa are Dr. D. Daniels, of the Colonial Office Medical Service, Dr. Stevens, and Dr. Christopher. Dr. Daniels has sailed for India in order to make himself acquainted with the recent observations of Surgeon-Major Ronald Ross, of the Indian Medical Service, connecting the spread of malarial disease with certain species of mosquitoes. The two other gentlemen referred to will go direct to Nyasaland, in British Central Africa, to study malarial disease in that locality; and will eventually be joined by Dr. Daniels. With the knowledge acquired in a comparatively temperate climate, where, however, fever has of late years been peculiarly fatal, the three medical officers will, at a later date, visit West Africa, possibly on the Niger. The Royal Society proposes to contribute towards the expense of the investigation, the British Government, through the Foreign and Colonial Offices, finding the remainder. It is estimated that the investigations will occupy about two years, and reports will be submitted from time to time to a Committee nominated jointly by the Royal Society and the Secretary of State.

IT will be remembered that the late Mr. Alfred Nobel left almost the whole of his fortune to be converted into an international fund for the advancement of scientific research (see NATURE, vol. lv. p. 232). The bequest gave rise to a dispute, which we are glad to learn has been settled by a compromise between the contesting parties. The relatives of the deceased will receive 3,800,000 Swedish kronor, or about 211,000*l*., so that there still remains for the prizes the sum of 25,000,000 kronor, or nearly 1,400,000*l*. The income, computed at the rate of 3 per cent., will make the five prizes worth 150,000 kronor, or 8300*l*. each. It is expected that the compound interest during the time, which will necessarily be long, that will elapse before the prizes can be awarded, will increase the capital so as to cover the cost of managing the funds and the work entailed in properly distributing the prizes. It will be remembered that these prizes are to be awarded annually to persons making the most important discoveries in physics, chemistry, physiology or medicine. There is also to be a prize for the best literary contribution upon the subject of physiology or medicine, and also one for any person who has achieved the most or done the best things looking towards the promotion of the cause of peace throughout the world.

M. A. MICHEL LÉVY has been elected a corresponding member of the Berlin Academy of Sciences.

WE regret to see the announcement of the death of Dr. James I. Peck, assistant professor of biology in Williams College, and assistant director of the Marine Biological Laboratory at Woods Holl.

THE first competition offered by the Nansen Fund, which was established soon after the return of the *Fram* in 1896, has just been advertised. The subject is a thorough work in embryology based on original investigation, and the amount of the prize is 1500 kroner (about 80*l*.) The result will be announced at the annual meeting of the Christiania Academy of Science, May 3, 1900.

THE Christmas Course of Lectures, specially adapted to young people, at the Royal Institution, will be delivered this year by Sir Robert Stawell Ball, F.R.S. The subject will be "Astronomy," and the lectures (which will be illustrated by models and the optical lantern) will deal with the sun, the moon, the inner planets, the great planets, shooting-stars, and new methods. The first lecture will be delivered on Tuesday, December 27, at three o'clock, and the remaining lectures on December 29 and 31, and on January 3, 5 and 7, 1899.

THE death is announced at Paris, at the age of seventy-four, of M. J. N. Raffard, distinguished for his inventions and papers on science and technology. His inventions include governors for engines, several ingenious dynamometers, and many other appliances; he was the first to construct in Paris an electric tram-car worked by accumulators. He was a member of the Committee of Mechanical Arts of the Paris Société d'Encouragement, and also of the Editorial Committee of the *Revue de Mécanique*.

SIR GEORGE BADEN-POWELL, K.C.M.G., whose death, at the comparatively early age of fifty-one, we regretfully announce, took an active interest in scientific affairs, and in many ways assisted the advancement of natural knowledge. He was the son of the Rev. Prof. Baden-Powell, the Oxford geometrician and geologist. In 1896, he rendered a most valuable service to astronomy by conveying a small party of observers to Novaya Zemlya to make observations of the total eclipse of the sun. It will be remembered that on account of unfavourable weather the eclipse was not observed in Norway, where most of the British observers were situated; but, fortunately, better conditions prevailed at Novaya Zemlya, and excellent photographs were obtained of eclipse phenomena. The total failure of the British expeditions was thus saved by Sir George Baden-Powell's timely aid. His death will be mourned by many friends in the scientific world.

SIR JOHN FOWLER, K.C.M.G., Bart., the distinguished engineer, died on Sunday, at the age of eighty-one. His name is associated with some of the greatest engineering triumphs of this century. He was responsible for the design and construction of the Underground (Metropolitan) Railway, and carried out the scheme successfully in the face of gigantic difficulties and great opposition. He was engineer-in-chief of the Forth Bridge, which he designed in association with Sir Benjamin Baker, and he planned and commenced in 1875 the Sudan Railway to Khartum, now on the point of completion. It was in consideration of his work for the benefit of Egypt that in 1885 the Queen conferred upon him a Knight Commandership of St. Michael and St. George. For his services in connection with the Forth

Bridge, he was created a Baronet in 1890. He was president of the Institution of Civil Engineers in 1866, and delivered from the chair a very memorable address on the requirements of a complete engineering education. In 1890 he received the honorary degree of LL.D. from Edinburgh University.

PROF. CHARLES-MICHEL BRISSE, whose death occurred on October 13, was born in Paris on September 8, 1843, and lived a life of activity and usefulness. He was professor of mathematics at the lycée Condorcet for twenty-four years, and he also held the posts of tutor at the École Polytechnique, supplementary professor at the Conservatoire des Arts et Métiers, professor at the École Centrale, and professor at the École des Beaux-Arts. He was the author of papers on the displacement of figures and on the general theory of surfaces, and he translated into French several English and German works on the higher branches of mathematics. He also published numerous memoirs on actuarial subjects. In collaboration with M. Andre and M. Rivière, he published two editions of a "Course de Physique" for use in classes of mathematical physics. He was connected with the *Journal de Physique* for many years, and an appreciative note upon his services to the journal and to science appears in the November number.

THE temperature-entropy or "theta-phi" diagram of a substance, in thermodynamics, has been made well known to engineers through the writings of Mr. J. Macfarlane Gray. Those who wish to become familiar with an actual theta-phi diagram, or to study the properties of steam by its aid, will be glad to know that a diagram for one pound of steam at temperatures from 100° to 400°, designed by Captain Sankey, is now published by Messrs. Albert Frost and Sons, of Warwick House, Rugby. The basis of the chart is the water line and saturated steam line, and the space between these is closely divided by constant pressure and constant volume lines, which are extended into the superheated steam field; lines of constant dryness-fraction are also given. There are scales giving total heat, water-heat, and internal energy, from which these quantities can be read off without interpolation.

MR. PHILIP E. BERTRAND JOURDAIN sends us several notes reprinted from the *Journal* of the Royal Microscopical Society, 1898, pp. 395–400, dealing with improvements in microscopic lenses, with especial reference to photo micrography. In the first of these notes he describes and figures an apochromatic objective and projection-ocular without fluorite, computed by Prof. Charles S. Hastings; but no information as to the precise nature of the glasses seems to be divulged by the makers. In a second note Mr. Jourdain describes a method of adjusting the sizes of the coloured images yielded by the Cooke lens; while a third note is devoted to a description of the planar lens recently computed by Dr. Rudolph, which, on account of its large aperture and wonderfully perfect astigmatic corrections, is admirably adapted for low-power micrography.

A SHORT article on the colours of lakes and seas, by Prof. Richard Abegg, of Göttingen, has been reprinted from the *Naturwissenschaftliche Rundschau*, xiii. 14. The author upholds the theory of Bunsen to account for the connection between the blueness of water and its purity: namely, that water itself absorbs red and yellow rays in preference to blue, and the purer the water the greater distance has the light to travel before being reflected by suspended particles, and therefore the greater the preponderance of blue. Bunsen's theory of selective absorption, combined with Soret's application of Tyndall's theory of the colours of the sky to water, are regarded by Prof. Abegg as affording a satisfactory qualitative solution of the question; but a number of interesting problems of a quantitative character still remain to be solved, and in this connection M. Spring's investigations are criticised at some length.

Some remarkable facts with regard to the electrical transmission of power in mining were brought forward by Mr. W. B. Esson in a paper read at the Institution of Civil Engineers on November 15. It was shown that the disadvantages attendant upon expensive transport of ore have been to a large extent neutralised by the electrical transmission of power. By using electrically-transmitted power the crushing-mills can be placed at the mine, and the serious expense of transporting the ore to the site of the water-power can thus be saved. Generally, electricity furnishes the only practicable means for transmitting power for mining operations, and the ease with which a copper wire can be carried over any kind of country, together with the plastic nature of the material, renders the electrical conductor the simplest and most trustworthy of all vehicles for power transmission. The plant erected at the Sheba Gold Mining Company's mine for the electrical transmission of power to the crushing-mills, five miles distant, was described by Mr. Esson, and the cost of milling was shown to be 1*s.* 8*d.* per ton of ore, as against 6*s.* 1*d.* per ton when aerial ropeway transport was used, and 1*l.* 12*s.* 6*d.* per ton during the time of ox-waggon transport. The water-power is obtained by a dam across the Queen's River, two miles above the generating station, to which the water is conveyed partly in open race and partly in tunnel. The maximum head derived is 32 feet. The turbines are of the Victor horizontal type, driving a countershaft of 300 revolutions per minute by ropes, and are together capable of developing 396 horse-power. The generating plant consists of three alternating-current dynamos supplying current at 3300 volts. The current is transmitted by cables to the mine, and at the receiving-house the pressure is reduced to 100 volts for driving motors and lighting the workings. The crushing-mill at Sheba works night and day; and in one year, of the possible 365 days of 24 hours each, the pressure cut off the conductors was only 4 days, 8 hours, 22 minutes, which were chiefly occupied in inspecting the water-race, overhauling the belts, ropes, &c., and in executing general repairs to the machinery. The efficiency of the plant from the turbine shafts at the generating station to the motor shafts at the mine may be taken as 70 per cent.

"IT is now some eighteen years since Mr. George Eastman, as an amateur photographer, began experimenting in a dark room in his own house with the intention of manufacturing photographic dry plates. . . . This was the modest beginning which blossomed in 1881 into the Eastman Dry Plate Company." So writes "Hermes" (*Commerce*, October 26, p. 785) in his interesting article under the heading "Every one his own photographer." Most of our readers have practised the art of photography at some time or other, and many have, without doubt, been users of the well-known Kodak and Eastman's films and papers. It is with these that the writer of the above-mentioned article deals; in fact, he gives an interesting digest of the history of this big firm since its commencement. So great and rapid has been the growth of this company, that in addition to their large manufactories in Rochester, New York, an equally large establishment has grown up in England, having its chief works at London and Harrow. The latter send their photographic materials over the whole world, with the exception of America, which is supplied from Rochester. Users of these materials will therefore read this article with interest, for not only will they be made acquainted with the numerous buildings and show-rooms by means of excellent reproductions, but the workshops and other manipulating sections are interestingly described by "Hermes," who has made a tour of all the company's premises.

THE *Engineering and Mining Journal* announces that Dr. Napier Ford has invented a substitute for rubber, namely perchoid, which is described as an oil that has undergone a high degree of oxidation. The oil is heated with litharge, stirred long and continuously, and then allowed to cool. Specially prepared tow is then dipped into it and placed in wire baskets, and exposed to air. The oil admitted to the filaments of the tow thus becomes wholly oxidised. This is drawn through rollers, and comes out a leathery material closely allied to, if not identical with, rubber. Its tenacity is increased by mixing sulphur with it. It is said that perchoid can be rolled as thin as a piece of tissue-paper, and that it makes leather impervious to moisture, though not to air.

SOME ten years ago a French missionary started the systematic rearing of two kinds of spiders for their web, and the *Board of Trade Journal* states that a spider web factory is now in successful operation at Chalais-Meudon, near Paris, where ropes are made of spider web intended for balloons for the French military aeronautic section. The spiders are arranged in groups of twelve above a reel, upon which the threads are wound. It is by no means easy work for the spiders, for they are not released until they have furnished from 30 to 40 yards of thread each. The web is washed, and thus freed of the outer reddish and sticky cover. Eight of the washed threads are then taken together, and of this, rather strong yarn cords are woven, which are stronger and much lighter than cords of silk of the same thickness. These spider web ropes are very much more expensive than silk ones, but it is hoped to reduce their cost somewhat in the future.

AT the meeting of the Academy of Science of St. Louis on November 7, Mr. James A. Seddon, of the Missouri River Commission, presented a paper on resistance to flow in hydraulics, in which the point was made that relatively a small part of this resistance, so far as open streams were concerned, was directly attributable to friction against the bottom and limiting banks, but that the resistance was found acting between accelerations and impacts, and showed in forced distortions of the free surface, from which forms the energy passed into internal motion.

WE learn from *Science* that the State Legislature of Vermont has passed an Act providing for the equipment and maintenance of a State laboratory, which shall include in its work "the chemical and bacteriological examination of water-supplies, milk and all food-products, and the examination of cases, and suspected cases, of diphtheria, typhoid fever, tuberculosis, malaria, and other infectious and contagious diseases." The sum of 1000*l.* has been granted for the establishment of the laboratory, and 1600*l.* per year voted for current expenses. Dr. J. H. Linsley is director of the laboratory. It appears that only three States have established similar laboratories—Michigan, Massachusetts and New York.

WE have received from Prof. B. Sresnevsky, director of the Iouriev (Dorpat) Observatory, the twelfth yearly report upon the rainfall of the Baltic provinces of Esthonia and Livonia. The observations refer to the year 1897, and contain monthly and yearly values, and the number of rainy days, for 125 stations, and the same values are also grouped into districts. Although not stated in the title, the work also contains temperature observations made at 8 a.m., and these are treated in the same way as the rainfall values. The ten-yearly mean of rainfall for the whole district is 21·9 inches, and the average number of rainy days is 162. The driest month is January, and the wettest, July. The general mean of the yearly temperature (for 8 a.m.) is 39°·4 (January 18°·5, July 62°·2). The results have been prepared by Dr. A. von Oettingen, formerly director of the Dorpat Observatory, and we are glad to see that, as soon as values for fifteen years have been obtained, it is proposed to issue a general summary, with diagrams.

THE Pilot Chart of the North Atlantic Ocean, published by the Hydrographer of the U.S. Navy for November, gives some interesting details of the track followed by the recent destructive hurricane in the West Indies. The centre of the storm passed to the southward of Barbados at 9h. 30m. p.m. on September 10; and reached Kingstown, St. Vincent, at noon on the 11th. From St. Vincent, the hurricane moved north-westward at the low rate of six miles per hour, and gales were experienced within a radius of 75 miles from its centre. On the 12th and 13th it was central to the west of the Lesser Antilles, turning to the northward on the latter date. On the 14th it continued its north-westerly course, recurving to the north-east on the 17th, near latitude 30° N. and longitude 71° W. The British steamship *Irrawaddy*, from port of Spain to New York, encountered the hurricane on the 11th, and kept within the storm area until the 18th; she had strong winds to gales of hurricane force throughout this period. On the 18th and 19th the storm pursued a north-easterly course, moving at the rate of twenty-five to thirty miles an hour, its area being increased considerably. The last report received by the U.S. Office was from the British steamship *Hesperia*. She reports, latitude 42° N., longitude 42° W., on September 20: "Winds S.S.W., force 10, shifting N.W., lowest barometer 29·62 inches; squalls blowing with terrific force; sea at times mountainous." The storm seems to have followed a somewhat more northerly and seaward course than the average track for September, as calculated by Padre Viñes in his investigation of the general movements of West Indian hurricanes, published by the Weather Bureau of Washington.

THE next volume of the *Transactions* of the Woolhope Field Club will contain a valuable paper (of which some copies have been printed) on the Hereford earthquake of December 17, 1896. The paper is the joint work of Mr. H. Cecil Moore, the Secretary of the Club, Mr. R. Clarke and Mr. A. Watkins, and gives the results of careful inquiries made in the central county of Herefordshire with regard to the damage caused by the earthquake. In the city of Hereford alone, it appears that 218 chimneys had to be rebuilt; but in the parish of Fownhope the damage was relatively greater, for twenty-two chimneys were repaired or rebuilt. The authors remark that a circle of six miles radius, with its centre at the centre of the ancient upheaval of the Woolhope Valley, includes by far the greatest damage in the conuty. The paper is illustrated by two plates, one showing the fractures in several pinnacles of Hereford Cathedral and other churches; the second being a map of the county, on which are marked the places where buildings were damaged.

THE Geological Survey of England and Wales has lately published short explanations of the new series maps relating to the country around Bognor and Bournemouth, by Mr. Clement Reid. We are now able to call attention to another explanation relating to Eastbourne, by the same author, and printed for H.M. Stationery Office, price 6*d.* It contains a general account of the geology of this favourite residential district, which includes not only Eastbourne, but also Newhaven and Seaford. The strata comprise the Cretaceous rocks from the Weald Clay to the Upper Chalk, the Lower Eocene strata, and superficial Drifts. Illustrations are given of the characteristic fossils. Mr. Reid calls attention to certain disturbances seen on the foreshore near Beachy Head, and a study of these leads him to conclude that the Chalk of the South Downs, unlike that of the North Downs, is not connected across the Channel with France.

Brief notes on water supply and economics are also given in this little pamphlet.

AMONG noteworthy acquisitions by purchase referred to in the Report of the Trustees of the Australian Museum, which has just come to hand, is the Mount Stirling meteorite, a mass of meteoritic iron weighing more than 200 lbs., found in Western Australia; a valuable collection of opalised reptilian remains, including the remains of the Mesozoic reptile *Cimolisaurus leucoscopelus*; a specimen of the very rare Golden-winged Parakeet (*Psephotus chrysopterygius*) from Port Darwin, only three examples of which are believed to be known; and some eggs of the Jabiru (*Xenorhynchus asiaticus*). The total number of acquisitions was 11,099, of which 7379 were presentations, 1455 were exchanges, 277 were purchases, and 1888 were collected by members of the staff. Sir William MacGregor contributed nearly one thousand ethnological specimens from his New Guinea Collection. The curator, Mr. R. Etheridge, jun., points out that the museum staff needs a trained collector. At present the funds at the disposal of the Trustees will not permit of such an appointment being made, which is regretted because museums and institutions in other countries send collectors to Australia and take away the best specimens.

FOREST resources are receiving increased attention in many places. A short time ago we recorded the establishment of the New York State College of Forestry for the professional education of the managers of the forests of the State. A report on the forestry conditions of Northern Wisconsin, containing the results of an investigation carried out by Mr. Fillibert Roth, has now been published by the Wisconsin Geological and Natural History Survey. As in many other cases, the forests of the State are shown to have been treated destructively. The wooded area is steadily being reduced, and at present nothing is done to protect or re-stock the "cut-over" lands, which are now unproductive waste land. Mr. Roth estimates that this policy causes a loss of 800 million cubic feet of wood per year to the State, besides driving from the State the industries which have been most conspicuous in its development, depriving a cold country of a valuable factor in its climatic conditions, and affecting detrimentally the character of the main drainage channels of the State. It is hoped that the report will aid in the formulation of rational forestry legislation, and so help to develop and restore the great forest resources of the State of Wisconsin.

MANY items of interest are contained in Mr. Edgar Thurston's report on the Madras Government Museum for the year 1897-98. How much appreciated the museum is may be judged by the fact that as many as 47,260 visitors have been admitted on a single day. The proportion of those able to sign their names to that of those unable to do so was about 1 : 6 on week days and 1 : 3 on Sundays. This is satisfactory as showing that Sunday opening continues to appeal to the educated classes, who are prevented by business from visiting the museum on week-days. Dr. A. G. Bourne made three tours during the year, viz. to the South Arcot district, the Palni, and the Shevaroy Hills. They were all undertaken with the view of filling gaps in the herbarium, and continuing the botanical survey. Particulars with reference to these expeditions, and the numerous specimens collected, are given in appendices to Mr. Thurston's report.

SOME remarks upon the practicability of destroying prickly-pear (*Opuntia Dillenii*) by means of the cochineal insect, are made by Dr. Bourne in an appendix to the report referred to in the foregoing note. Dr. Bourne points out that the historical evidence weighs entirely against the practicability of destroying prickly-pear by the cochineal insect. There seems to be no doubt but that the cochineal insects and the cacti are all introductions, and the net result has been that the yellow-flowered cactus has thoroughly naturalised itself, while the cochineal insect has just managed to struggle on here and there. There is evidence that cochineal insects were introduced five times between 1795 and 1883, with a view to the establishment of the cochineal industry in the country. In 1807 Government offered a reward of 2000*l*. for its successful introduction. It never became thoroughly established. It was, however, possible that, although a fine variety of the insect best for industrial purposes would not flourish, a wilder variety might become more or less naturalised. This has occurred to a small extent, and the idea of utilising this to destroy prickly-pear has been from time to time put forward. Dr. Bourne's investigations, however, show that it is impracticable to destroy prickly-pear by the so-called "wild" variety of the cochineal insect; and even if the scheme were practicable, he doubts the advisability of encouraging the development of an insect which might eventually become an infinitely greater pest than the prickly-pear.

A CATALOGUE and price list of the papers of the late Prof. E. D. Cope, arranged chronologically, with a price list of plaster casts, has been issued by Mrs. Cope, Haverford, Pennsylvania, U.S.A., who offers the papers and casts for sale.

TWENTY-FIVE papers on diseases of children will be found in the ninth volume of *Transactions* of the American Pediatric Society, edited by Dr. Floyd M. Crandall, and just published. The address of the president, Dr. Samuel S. Adams, deals with the evolution of pediatric literature in the United States.

A NEW edition of Babington's "Manual of British Botany" is in preparation by Messrs. H. and J. Groves. The first edition of this work was published in 1843; the eighth in 1881. It is hoped that the forthcoming edition—the ninth—for which the late author had accumulated many notes, may be ready early in next year.

DR. F. KRANTZ has issued a good catalogue (printed in German, French, and English) of minerals and geological specimens which he has in stock at the Rheinisches Mineralien-Contor, in Bonn. The catalogue contains particulars as to many collections of minerals arranged for purposes of instruction, and also for use with specified text-books of mineralogy. Lists of instruments and appliances used in the examination of minerals are also included.

THE additions to the Zoological Society's Gardens during the past week include two Red-sided Eclectus (*Eclectus pectoralis*, ♂ ♂) from New Guinea, presented by the Chevalier Angelo Luzzati; two Undulated Grass Parrakeets (*Melopsittacus undulatus*, ♂ ♀) from Australia, presented by Mr. A. J. Finch; a Booted Eagle (*Nisaetus pennatus*) from Southern Spain, presented by Captain T. E. Marshall, R.A.; two Tawny Owls (*Syrnium aluco*), British, presented by Mrs. Borrer; a Red-fronted Amazon (*Chrysotis vittata*) from Porto Rico, presented by Mr. G. A. Phillips; a Cereopsis Goose (*Cereopsis novaehollandiae*) from Australia, presented by Sir Cuthbert Peek, Bart.; two Gold Pheasants (*Thaumalea picta*, ♂ ♀) from China, presented by Mr. W. A. Upton; two Red-bellied Wallabys (*Macropus billardieri*, ♂ ♀) from Tasmania, presented by Major C. J. Urquhart; a Red and Yellow Macaw (*Ara chloroptera*), a Blue and Yellow Macaw (*Ara ararauna*) from South America, presented by Mr. W. Murray Guthrie; two Vulpine Squirrels (*Sciurus vulpinus*, ♂ ♀) from North America, a Slaty-headed Parrakeet (*Palaeornis schisticeps*) from Northern India, deposited; a Hyacinthine Macaw (*Anadorhynchus hyacinthinus*) from Northern Brazil, a Hobby (*Falco subbuteo*) from Holland, purchased.

OUR ASTRONOMICAL COLUMN.

THE ANDROMEDES.—As regards the return of the Andromedes, there is every reason to believe that by this time the shower will have passed by the earth's orbit. Brilliant displays were observed in 1872 and 1885, on November 27 in each year; and it would naturally be inferred that on the same day of the present year, which corresponds to an equal interval of time, a like occurrence should take place In 1892, however, the earth passed through this stream on November 23, and it has been computed that this recession of the node was caused by the perturbations of Jupiter, which were responsible for this difference of four days. If the observations made on the 23rd have indicated that this date is somewhat too early, observers should be careful to watch on the following nights, for, after all, the exact time of reappearance cannot be definitely foretold. The radiant point of this shower is in Andromeda ($25^\circ + 43^\circ$), and, therefore, at this time of the year at a great altitude. Unlike the Leonids they move slowly, as they have to overtake the earth in her movement round the sun.

A close watch on the night of the 22nd was kept at the Solar Physics Observatory, South Kensington: but the usual fog made its appearance at about 9 p.m., and became thicker towards midnight. Altogether *three* meteors were seen between 8.30 p.m. and 12.15 a.m., but none of these were Andromedes.

THE PLANET JUPITER.—The markings on Jupiter, which are involved in the dense atmosphere around him, have been subjected to minute observations for many years, and it is now that we are beginning to learn something of the circulation in operation on that planet. That the atmosphere does not rotate homogeneously has for many years been known, and the movement of the great red spot may be given as an instance of this irregularity. Mr. Stanley Williams, a faithful observer of Jupiter, showed clearly in 1888 that there existed a swift southern current which extended from latitude -37° to -55°. In a more recent communication (*Astr. Nach.*, No. 3528) he has published the results of observations of two southern spots within this zone which were visible, one in 1890 and the other two years later. The object of these observations was to investigate whether such a current is a permanent feature of the planet or not, and to trace from year to year the variations that may occur in the velocity of its motion.

Without entering into the details which are given in his article, we will limit ourselves simply to his results. The following table shows the periods of rotation obtained, the first being an observation by Prof. C. A. Young in 1886 of a small white spot in latitude 50° south.

Year.	Limit of lat.	Rot. period. h. m. s.
1886	-50°	9 55 11·1
1888	-37° to -55°	0·9
1890	-36° to -45°	6·7
1892	-32° to -39°	8·4

A glance at the figures in the last column shows that this southern current is not only a permanent feature of the planet, but that its velocity is not constant. As regards the limit of the zone in which this current exists, we are told that the current may extend further southwards, and perhaps even to the pole itself.

We hope that Mr. Stanley Williams will continue his observations in this region, and settle this question of limit, which is important in the light of the general atmospheric circulation of this planet.

THE PERSEIDS OF 1898.—In August last the weather was so favourable that at a great number of places observations of the Perseids were successfully made. A not unimportant feature of the display was the large number of meteors that did not radiate from Perseus at all, and this fact is very clearly brought out in the description and chart of the observations made by Messrs. Vacca and Senouque on the nights of the 10th to the 16th (*Bull. Soc. Astronomique de France* for November). It must be mentioned that at Paris, where these observations were made, the night of the 10th was not very clear; so the majority of the observations were made on the following nights.

An examination of the diagram shows several distinct radiant points, not only in Perseus, but in Cassiopeia, Cygnus, and the Great Bear.

Another set of interesting observations, made by M. Fournier, is published in the same journal, and contains also a reproduction of a chart, showing the trails recorded. This, however, is restricted to the night of the 10th, which was beautifully clear at the place of observation, and the chief radiant point deduced is well defined near η Persei. Out of sixty meteors observed, thirty-nine were Perseids, five or six sporadic, and some others apparently radiating from Cassiopeia.

ASTRONOMICAL SOCIETY OF WALES.—The last two monthly numbers of this Society's publication, the *Cambrian Natural Observer*, show that interest in astronomical phenomena is by no means at a low ebb, but rather verging on a spring tide. The October number contains some interesting notes about Gruithuisen, who was for some time editor of the *Jahrbuch*. His great speciality was a study of the lunar features; and although ridiculed, he was nevertheless "an assiduous and careful observer." Mr. Denning contributes some notes on meteoric fireballs, and describes how observations should be recorded. He gives, also, the right and the wrong way of recording them, or rather, we should say, the useful and the useless, from published examples, and we cannot help quoting them as guides to future recorders.

"On June 10, 1891, I saw a beautiful phenomenon. Suddenly at the zenith, east of the Great Bear, shone forth a yellow globe like Venus at her brightest. Dropping, somewhat slowly, it fell obliquely southwards. As it passed in its brilliant career, it lighted up its dusky path with a glorious lustre. When it had descended about half-way down towards the horizon, it burst into a sparkling host of glorious fragments, each dazzlingly shot over with all the hues of the rainbow."

The useful record was as follows:—

Date and time.—1892 December 12, 11h. 22m. G.M.T.

Object.—Fine meteor, nearly = Jupiter.

Path.—$55^\circ + 41^\circ$ to $45^\circ + 20^\circ$; length 22°.

Duration of flight.—1·2 seconds.

Colour.—Bluish-white.

Appearance.—Brightest in latter portion of its path, where it left a white streak for about one second.

Probable radiant.—ϵ Ursae Majoris.

The November number is especially a "meteor" number, and contains information on the observation of these bodies by Denning, Johnstone Stoney, Carslake Thompson, &c.

PHOTOGRAPHIC PLATES AND THE SPECTRUM.—In laboratories and observatories where a study is made of gaseous and metallic spectra by the aid of photography, it is important to make use of the differences between the sensitiveness of the numerous photographic plates which are obtainable. For that particular part of the spectrum which may be under investigation, it is always desirable to employ the greatest photographic action possible, and this can only be done by preparing plates which are most sensitive to this region. A very interesting comparison of the sensitiveness of various plates for the different regions in the spectrum is given by Mr. E. Sanger Shepherd (*Journal of the Camera Club*, vol. xii. No. 150), in an article on the photographic reproduction of paintings; and curves are added, showing clearly how each of the plates behave.

Comparing the Cadet spectrum plate and the Ilford chromatic plate, the former gives action beyond the D line, whereas the latter ceases at the D line; there is very little red sensitiveness, which is perhaps the worst feature of the plate, and there is a gap in the green. Lumière's panchromatic plate has extreme red sensitiveness; but except for a small gap, in the green it is sensitive all through the spectrum. In Lumière's "B" plate the sensitiveness in the red is very considerable and more extensive than in the plate preceding, but there is a very long gap in the green. Edward's snap-shot isochromatic plates have considerable sensitiveness in the green and yellow, and a little less in the red; the curve is here much smoother, and not subject to such great changes.

In the Cadet lightning spectrum plate we have extreme sensitiveness from the blue to the yellow, and yet sufficient red sensitiveness for many purposes. Considering the whole spectrum, it seems to be the best plate for uniformity throughout, and the small gap in the extreme red makes it possible to use a considerable amount of light for developing.

Although it is not absolutely necessary, it is always more convenient to develop in a room lighted sufficiently to see how the image appears. Many photographers do not pay sufficient attention to the purity and colour of light that is admitted. The gaps in the sensitive curves point out clearly those rays which have least action on the plate, and which should therefore be

used as light filters. Thus for Lumière's "B" plates we must have a bright chromium green, a deep pot-green glass, together with aurantia; while for Lumière's "A," we should use a red light consisting, for instance, of aurantia, naphthol yellow and fuchsin films. For Thomas's plates a faint green or a fairly bright red glass with a strong tint of aurantia dye might be employed. Edward's snap-shot isochromatic and rapid spectrum plates require the quality of the filter light to be very pure.

THE CHEMICAL SOCIETY'S BANQUET TO PAST-PRESIDENTS.

REFERENCE has already been made to the banquet given on November 11 to Sir J. Henry Gilbert, Sir Edward Frankland, K.C.B., Prof. W. Odling, Sir Frederick Abel, Bart., K.C.B., Prof. A. W. Williamson, and Dr. J. H. Gladstone, Past-Presidents of the Chemical Society, who have been Fellows of the Society for fifty years or more. The idea of expressing in this way the high regard in which men of science hold the work of these distinguished chemists was an excellent one, and it was well carried out. The large number of congratulatory telegrams and communications received on the day of the banquet from every country where the science of chemistry is cultivated showed that the whole civilised world was in sympathy with the object of the banquet. Communications were received from France, Holland, Belgium, Germany, Sweden, Russia, Austria, the United States, and several other countries. Prof. Friedel wrote: "I should have been happy to associate myself with the Chemical Society in doing honour to these veterans of science. I have the honour to be the friend of most of them, and the beneficent action they have exerted on Chemical Science cannot be esteemed too highly. They form the finest phalanx of the Fathers of our science which exists in any country. With these sentiments you will understand the liveliness of my regret to be able to take part from afar and in spirit only in the honour paid them." At a meeting of the Russian Chemical Society the following was passed: "That the Society avail itself of the exceptional opportunity of being able to congratulate conjointly Sir Joseph Henry Gilbert, Sir Edward Frankland, Prof. Odling, Sir F. A. Abel, Dr. A. W. Williamson, and Dr. J. H. Gladstone, whose distinguished services during half a century stand out as a model for all investigators in chemical science, and also express the wish to see the further results of their labours in the annals of science for many years to come." A telegram from the German Chemical Society contained the message: "The sister Society sends both Jubilee congratulations and greetings to the Jubilee celebration of the Presidents of the Chemical Society, Gilbert, Frankland, Odling, Abel, Williamson, and Gladstone." These messages show that the distinguished men to whom the banquet was offered are held in the highest esteem in all places where chemical studies are carried on.

We regret that the limitations of space will not permit us to print the speech in which the President, Prof. Dewar, who occupied the chair at the banquet, alluded to the work of the six Past-Presidents, nor can we find room for any speeches other than those in which these distinguished men replied to the toast in their honour.

Sir J. Henry Gilbert said:—"After the extremely flattering and eloquent terms in which our President has referred to the work of the six Past-Presidents of the Society who are so highly honoured to-night, it is surely a difficult task to say anything in response. I feel that any words of mine would be entirely inadequate; and I must, I think, fall back on what I was intending to say, and give a little personal history of the early times of the Society. You are aware, most of you, that I am to night in the position of the senior of the Past-Presidents, in consequence of the death of Lord Playfair. He was, as you know, one of the founders of the Society, and, before he died, the only survivor of those founders. I myself came in within three months of the foundation, and so had some knowledge of the Society's early doings. In fact, before I was really admitted to the Society, under the influence of the late Professor Graham, I undertook the translation of a paper by Redtenbacher and Liebig on 'The Atomic Weight of Carbon,' and that paper occupies eighteen pages in the first volume of the Society's 'Memoirs.' I should say that, less than a fortnight ago, I received a letter from Lady Playfair, just before she left to visit her friends in America, in which she said with what interest he had looked forward to being present at the banquet appointed for June—but that was not to be. I first made the acquaintance of Playfair in Liebig's Laboratory at Giessen, the year before the establishment of this Society, that is, in 1840. Playfair was at that time very busily occupied in translating the memorable work of Liebig, 'Organic Chemistry in its Applications to Agriculture and Physiology'; and before the session was over he left for this country with Liebig, who was to present the substance of that work as a report to the British Association at Glasgow in September. You may be interested to know who there were from this country in Liebig's laboratory at that time. Besides Playfair and myself, there were Dr. William Allen Miller, afterwards professor of chemistry at King's College; Dr. Stenhouse, who has contributed so much to the *Journal* of this Society; Dr. Angus Smith; and, lastly, Dr. Edward Schunck. He and I are, I believe, the only survivors of that time among those from England who were with Liebig then. Of the Germans who were there, some of the names you will probably remember. There were Heinrich Will, Varrentrapp, Redtenbacher, Hermann Kopp, Scherer, Bromeis, Boeckmann, and others, of various nationalities; but I believe that not one of these survives at present. Schunck joined the Society early in 1842, and he from that time to this has devoted himself to scientific investigation. He built a laboratory, and a museum devoted especially to specimens of organic bodies, in his own grounds on the other side of Manchester, where he still lives. He was, in fact, the oldest member of the Society, I believe, except Playfair and myself. He has worked indefatigably ever since; but I am very sorry to say he is not able to be here to-night, having had an attack of bronchitis, which renders it impossible, though it would have given him great pleasure to be present. Referring to that time at Giessen, I may say that Playfair, Stenhouse, and myself, each took our degree then; and Playfair, though joining with us, having gone with Liebig, the responsibility was left with Stenhouse and myself to give the usual supper to the other students of the laboratory, and a few distinguished guests, among whom was Bunsen, who was then at Marburg; and who, I am glad to learn from Sir Henry Roscoe, is still well. Stenhouse was much my senior. We had a large and lively party, but Stenhouse did not enjoy that sort of thing very much, and when the last bottle of champagne was opened, he said: 'Now, Gilbert, I shall leave you to it,' and away he went. That was, however, not near the end of the evening. They stayed a very long time, and we did not exchange the smoky atmosphere of the supper-room for the clearer air outside until early morning. We then went round the boulevards of the little town, the Germans singing students' songs, and coming in time to the hotel where Stenhouse lodged, we serenaded him from the outside. Then some one tried the door, and finding it unfastened, the whole party went up, lighted candles, and serenaded him in bed. Next morning there was a very capital caricature brought out, showing Stenhouse's rather long nose pointing in one direction, and his longer nightcap in the other. But this is enough of this kind of history, and I must now turn to rather more serious matters. It was in 1843 that I became associated with Mr. (now Sir John) Lawes in agricultural investigation—a collaboration which has now extended over more than fifty-five years. As you all know, however rude may be some of the methods of the art of agriculture, the investigation of the principles underlying its practices involves a wide range of scientific inquiry. It involves the chemistry of the atmosphere, of the soil, of vegetation, and of animal life and growth. That is to say, besides chemistry, it involves meteorology, botany, vegetable physiology, and animal physiology, to some extent. It is impossible to be a specialist in so many subjects, particularly in these days, and I can only say that in venturing to deal with these other branches of science we have taken great care to avoid mistakes. The wide range of the investigations must be accepted as some explanation of the fact that we have not contributed more of the results to the Chemical Society. Many of them being connected largely with other branches of science, have been recorded in other than purely chemical journals; whilst those having a more directly practical bearing have been published in the *Journal* of the Royal Agricultural Society, or in other agricultural publications—the Rothamsted papers now numbering considerably more than 100. But we feel that, however long or short may be the time that we shall still work

together, we shall perhaps have done as much in opening up as in solving problems ; and that we shall certainly leave plenty for our successors to do. In conclusion, considering that there still remain five of your honoured guests to speak, this is all I will say of my own career, and I will only now ask you, Mr. President, the Council, and the Fellows of the Chemical Society, to believe that I esteem very highly the great honour you have conferred upon me to-night."

Sir Edward Frankland—"Allow me to thank you, Mr. President, and the Council of the Chemical Society for this delightful entertainment which you have prepared for the Past-Presidents who have attained Jubilee rank. It was a generous, unique, and happy idea, which I feel sure we all heartily appreciate, not only as we sit at your hospitable board, but also when we reflect on the kind feelings which led to the conception of that idea. There used to be a phrenological organ entitled 'love of approbation,' and whether there is or is not a part of the brain told off to perform this function, I trust that chemists are not behind the rest of humanity in appreciating such an honour as you have conferred upon us on this auspicious occasion. Nothing could be more agreeable than thus meeting so many colleagues who are worthily keeping up the high reputation of the Chemical Society. There is but one drawback to our enjoyment, and it has been very feelingly alluded to by Sir Henry Gilbert, namely, that one who so recently stood at the head of our Past-Presidents should not still be present amongst us. In the lamented death of Lord Playfair, chemistry and science generally have sustained an immeasurable loss ; for he was a binding link between science and the State, always ready to fight for the cause of truth against prejudice and ignorance, and never ceasing in his efforts to bring home to our rulers the vast importance of the applications of science to the progress, health and prosperity of the nation. As one of his first pupils, and after a life-long friendship, I may be permitted to testify that his energy in this cause was prompted by sincere convictions and not by political exigencies. Had Playfair lived a few months longer, we should never have had the misfortune to make the acquaintance of that new variety of *Homo sapiens* the 'conscientious objector,' who is just now giving so much trouble to our magistrates. This is not a time to sketch, even in merest outline, the epoch-making work of the Society, but I may at least state my conviction that it will be found, on comparing the volumes of our *Transactions* with those of the corresponding societies of other lands, that, considering the number of workers in each case, England is not behind any other nation in research work, and this in spite of the almost total absence of that lavish State aid which nearly every other civilised nation enjoys. In view of the vast number of discoveries pouring out from chemical laboratories, I hear it suggested that the day is not far distant when there will be nothing left to discover, when all the elements in the cosmos shall have been captured and fitted into the periodic system of Newlands and Mendeléeff, when there is not one more gas in the atmosphere left to be detected, and every element and group of elements shall have its ortho-, para-, and meta-position assigned to it. What will then remain to be done? Fortunately for investigators, we shall still be only as children gathering pebbles on the shore of the great ocean of knowledge. As yet we have only found the big boulders. To change the metaphor, chemistry now occupies the position of geography a century ago. The enormous number of chemical compounds are like so many islands, their latitude and longitude ascertained with precision, but on which the foot of man has not been put down, whilst their animals, plants, and minerals have never been exploited. When the ideal state of knowledge has been attained, chemists will perhaps find time to explore this vast archipelago, in which, there is no doubt, many interesting discoveries await those who shall undertake the task. Who can set a limit to the usefulness of these explorations? Even the most unpromising compounds may turn out valuable prizes! When aniline, chloroform, and carbolic acid were discovered, who could have predicted the revolutions in the arts and surgery which these bodies were destined to produce! They were but as desert islands until they attracted the attention of Hofmann, Perkin, James Simpson, and Lister. As chemists, I believe we have a noble future before us. Chemistry is distinguished from all other branches of knowledge as the helpmate of nearly every other science. The geologist, the botanist, and the physiologist find no thoroughfare unless they call in the help of the chemist. As soon as the physicist breaks into a molecule, he is trespassing on our domain. The bacteriologist has found that it is not the waggling of the tail of a pathogenic microbe that is the most important feature of its history, but that the chemical compounds which it secretes demand his closest attention. Even the astronomer has already to sit at the feet of the chemist! Thirty-three years ago, when our worthy President was but a youth, there was once a dinner party composed chiefly of chemists held at the 'Albion.' A few are still living—among them being Sir F. Abel, Prof. Odling, and myself. In an after-dinner speech on that occasion, my friend Abel is reported to have expressed himself in blank verse as follows (I hope he will forgive me, at this distance of time, for appropriating his words to my own use):

"'Looking to right and to left, I see many faces around me,
Faces so old and familiar I feel once again at the College,
Testing, as in former times, for chlorine with nitrate of silver,
Gazing with youthful delight at crystals just hatched in a beaker,
Yearning o'er aniline drops distilling from crystal alembic.
O! my dear friends, one and all, we have toiled up a difficult pathway!
Some are low down on the hill, and others are near to the summit.
Let us remember the past and forget not our absent companions;
Fortune may come to us all; but youth will return to us never!'"

Prof. Odling:—"I do not know that I can better commence the few observations I propose to make to you than by following in the wake of my predecessor, Sir Edward Frankland, and saying that it is no less a great pleasure than my bounden duty to express to you, Mr. President, and to the Council and Fellows of the Society, my heartfelt thanks for the great compliment that you have paid to my colleagues and myself on this long-to-be-remembered occasion. Speaking, however, for myself personally, it is not the first time that I have had evidenced to me the kindly feeling of the Chemical Society. On the occasion of my retirement from the Secretaryship in 1869, I had also the special honour done me of being entertained at a dinner by the Society; and I also received a further token of their goodwill in the form of a capacious loving cup of no inconsiderable value in itself, but of far greater value as a perpetual mark of the kind feeling towards me of those with whom I had been for so many years so intimately connected. Those of us whom you entertain this evening have for a long period of time, as Sir Henry Gilbert and Sir Edward Frankland have already remarked, been associated with one another in common pursuits and enjoyments; and if there is one thing more than another that enhances to me the gratification of this meeting, it is the pleasure of finding myself associated still with my old friends and colleagues, Gilbert and Frankland and Williamson and Gladstone, and my earliest friend of all, Sir Frederick Abel. We have been concerned with one another in a large number of undertakings, and for a long period of time have been accustomed to hear one another's voices as well upon festive as upon scientific occasions. But we have not been accustomed to hear them in exactly the order they have been arranged for this evening. I have always looked upon myself, not as a precursor, but as a follower of Williamson. It has been my pride to reckon myself one of his adopted pupils—a disciple of his ideas more perhaps than many of those who were his actual pupils. He was always very decided in his notions. Sometimes, indeed, I turned a little restive, but was always soon pulled up into form again—sometimes more abruptly, perhaps, than was quite agreeable at the moment. At one time I laboured under the sad suspicion of being a little unsound as to the Atomic Theory. Well, perhaps I was not altogether so stalwart in its defence as I ought to have been; but I can assure you that I was never really guilty of so reprehensible a heresy as that which was attributed to me.

"You are doing us honour here this evening not so much, or not only, as students of the science of chemistry, but also as Past-Presidents of the Chemical Society. As ancients of that Society, we may all of us perhaps be permitted to talk a little about ourselves without incurring the imputation of egoism, and also to talk a little about old times without incurring the reproach, after our fifty years' fellowship, of senile garrulity. At the period during which I acted as one of the Secretaries of the Society, and my colleague, Prof. Redwood, concerned himself mostly with the business department of our affairs, the Chemical Society had not developed very far its function as a publishing agency, and as a consequence, even for that little prolific time, we did not get our fair share of important papers communicated at first hand to our meetings. But if we did not receive elaborate communications, we enjoyed the benefit of elaborate discussions; and there was no new class of compounds,

no newly propounded doctrine, no new reaction which was not submitted to our keen examination and controversy. The subjects of several of those controversies, and even the fashion of them, still linger in one's memory. I need scarcely say that chemical theory came in for a large share of our attention. The molecular weights of water and carbonic acid, the atomic weights of oxygen and carbon, and, above all, the then newly introduced idea of polyatomic radicles, were keenly discussed. We were a little too late for the interesting question as to whether compound radicles could possibly be oxygenous; but still, radicles were predominant at that time in chemical science, and reigned with undisputed sway over the whole domain of organic chemistry. One cannot but reflect how fleeting has been their reign. The doctrine of radicles has now sunk to an entirely subordinate position in chemistry, not unlike, may I venture to say, the subordinate position into which radical doctrines have fallen in a different sphere. There was one particular controversy I remember very well, and am sure Frankland will remember also. It was of this kind: whether the bodies called ethyl and methyl were really ethyl and methyl at all, or something else. Well, a question of that kind in those unsophisticated days had to be answered definitely by a plain aye or no. There was no loophole for escape or trimming, no possibility of saying that the one answer was just as true as the other, according to the point of view taken; nor was there existent in that period of innocence, for the solution of yet more puzzling problems, what we know now by the name of tautomerism, by which we learn that a body is, and at the same time is not, what it is alleged to be: that it is sometimes one thing and sometimes another, and sometimes both together, and yet preserves its individual chemical entity. In those days the principal provider of chemical material for our meetings was far and away Hofmann. He was in the habit of sending his multitudinous papers to the Royal Society for publication; but he gave us the advantage of his presence and his personal disquisitions; and I would appeal to all in this room who had the advantage of seeing him to say if they can possibly forget his appearances at the blackboard of the Chemical Society, and the enthusiasm and lucidity of his expositions of different points of chemical constitution, enlivened as they were by that extraordinary display of vivacity so inconsistent with the quiet phlegm we are in the habit of attributing to those of his nationality. But, despite the productiveness of Hofmann, still there were evenings on which something else was required; and then it behoved the Secretary to search far and wide for material to bring before the meeting of chemists who, with Greek-like avidity, were always clamorous for 'some new thing.' At that period the activity of the Giessen school was somewhat on the decline, and we looked for novelties in chemistry, as for novelties in mantles and millinery, to Paris. We had for our consideration the acidic ammonias of Gerhardt and the diatomic glycols of Wurtz, and the production of alcohol without the aid of either sugar or yeast, by Berthelot; and many other remarkable contributions to the knowledge of the day. But our friends across the water, with so much—so very much—justly due to them, nevertheless did manifest now and then a tendency to appropriate to themselves what did not altogether belong to them; and in this the country of Black and Priestley and Cavendish and Dalton and Davy, we were astonished one fine morning at being informed that 'la Chimie est une science française.' But even with the productiveness of Hofmann and the searchings of the Secretary, it did sometimes happen that our bill of fare was a little meagre. But what of that? Those were supper-eating days, and a meeting rendered brief by want of pabulum could always be supplemented by a prolonged and substantial, and, I may add, a musical, meal at a then well-known resort not far from Covent Garden; and when it happened, as it did sometimes, that our proceedings were not so exhilarating as they should have been, when divine philosophy had proved less charming than its wont, Hofmann, despite the abundant supply of tea and coffee of excellent quality, would, with a burst of inspiration, thrust forth his right hand and say: 'I will tell you, we will have a punch!

"But the Chemical Society has a future to look forward to, as well as a past to look back upon. At the Jubilee of the Society some seven or eight years ago, it devolved upon me to give an account within the short period of a quarter of an hour—I believe I occupied twenty minutes—of the progress of chemical science during the preceding fifty years. But to-day is also a Jubilee or almost so, the Jubilee of our incorporation by Royal Charter, which, in the then days of our insignificance, Playfair did so much to obtain for us. Now, on this diamond Jubilee, I ask you how many minutes will you give me to lay before you a forecast of the chemical progress that may be expected to take place within the next fifty years? I will only venture to say that, judging by the number and activity and intellectual gifts of the workers of the present day, we may feel assured that the achievements of English chemistry and the progress of the Chemical Society in the past will be as a mere nothing to the brilliancy which they will attain to in the future."

Sir Frederick Abel—"Sir Edward Frankland has out of his vast stores of knowledge recalled a fact of which I confess I was ignorant, that in years past I indulged a poetic fancy. I only wish I might now be inspired in order to find words to express on behalf of myself and my old friends our appreciation of this glorious reception which you have given us. The Chemical Society is endeared to me in many ways. Among the epochs of a somewhat long career of ceaseless activity, that which connected me intimately with the work of the Society is one of those which I recall with the greatest pleasure and satisfaction. And it so happens that the years of my connection with the Society in various functions were years in which some of the most memorable events in its annals occurred. As Treasurer, it was my privilege to arrange with the illustrious chemist and brilliant orator, Jean Baptiste Dumas, for the delivery of the first of those memorable lectures which were given through the agency of the Chemical Society in honour of the memory of Michael Faraday. While I was Treasurer, the volume of the *Journal* of the Society, which was then of modest and slender dimensions, nurtured by well digested extracts from foreign journals, speedily gained proportions unwieldy in character, so unwieldy, in fact, that the one volume split up into two before long. In the first year of my Presidency, the Research Fund, which was initiated in a modest manner by Mr. Thomas Hyde Hills, was placed upon a firm and substantial basis through the generosity of one of the most respected of the Society's original members, Dr. Longstaff; and in the second year in which I held that office, the somewhat revolutionary agitation which was persisted in by a not unimportant section of the younger Fellows of the Society, an agitation which, by the way, has been imitated since—led to earnest deliberation and consultation between the Council and some of its chosen members outside the Council, which resulted in the birth of an institution now flourishing exceedingly, which has become the guardian of the best interests not only of the chemical profession but also of the public. I of course allude to the Institute of Chemistry of Great Britain and Ireland. When I look back to the early days when I first owned the proud title of F.C.S., and remember my attendance, in a small room at the Society of Arts, at the meetings of the Chemical Society, presided over in succession by William Brande and Phillips, the business being managed by George Fownes and Robert Warington, the founder of the Chemical Society, and the funds not very cleverly handled by dear old Robert Porrett, one of the most prominent forms that appears in my mind's eye is that of the favourite pupil of Liebig, my venerated master, Hofmann. In the very first years of the Society, Hofmann became the very life and soul of it. He was beloved by his English brethren directly he came among them, and for years he was by far the most prolific contributor, either himself or through his pupils, to the volumes of the Society. Pardon me if I have been tempted into reminiscences; it is difficult to avoid it at such a gathering as this. The welcome you have given to the veteran Past-Presidents will remain in their minds to their last day as one of the great joys of their lives. To the many old friends and colleagues whom I see around me—Past-Presidents who, as men of science, hold positions second to none, whose names are familiar as household words—to them I can wish no higher gratification than that they may live to experience the satisfaction of such an entertainment, and of such a graceful appreciation of their work, as has been the lot of your old Past-Presidents to-night."

Prof. A. W. Williamson—"I thank you, Mr. President, most heartily for the kindly words you have uttered in relation to me, and to my efforts for the advancement of chemistry. It is an immense satisfaction to me to see a man of your talents and vast acquirements placed in so influential a position as that which you so worthily occupy. But whilst thanking you I am

bound to confess that I have heen for some time past a most unworthy member of the Chemical Society It happened that after a good many years of work in our Society, I had other matters of such importance claiming my time and attention, that I was unable to continue to work amongst my colleagues and friends in the Chemical Society.

"Before I came over in 1849 to work at University College, I had become acquainted in the Giessen Laboratory with that most remarkable man, August Wilhelm Hofmann, and I may mention a characteristic incident illustrating his earnest and steadfast devotion to his science. He had for a considerable time been working at derivatives of aniline, and in order to carry on these researches as effectively as possible, he prepared by the action of caustic potash on indigo about some two gallons of aniline. The product was placed in a big bottle on the mantelpiece in his bedroom, and the story goes that he used to stand and gaze at it for some time every morning and evening, and gloating over it with delight would think, 'what a number of splendid products I shall make out of this aniline!' The energy and devotion with which he followed up his work on the derivatives of aniline at the expense of many other researches which he might with advantage have followed up was such that he came to be talked of as the great worker on aniline, and Sir Benjamin Brodie somewhat prematurely wrote his epitaph in the following words, 'Hic jacet Aniline' His researches extended, however, at an increasing rate into other and wider departments of chemistry, and his energy and enthusiasm were such as to make him the leading explorer in the domain of organic chemistry. Berzelius had been for a lengthened period the one great man in the domain of inorganic chemistry, which was the only part of the science which had been explored to any appreciable extent. When I saw the vast piles of knowledge which Hofmann was so rapidly accumulating in the new domain of chemistry, I felt, and ventured to say, that his masterly labours entitled him to be called the Berzelius of Organic Chemistry. I happened to be present at a meeting of the Chemical Society at which a young chemist read a paper in the presence of Hofmann on some theoretical matters of importance which had already engaged the attention of distinguished chemists. Hofmann did not enter into any particulars of the paper, but he gave vent to an outburst of heartfelt delight at the simple narrative which had been read. There are various incentives to work, but the most potent incentive to earnest and efficient work is probably the example of a man like Hofmann, whose whole delight lay in mastering the truths of science, and in learning more and more particulars of the order of nature, and Hofmann possessed that power in a most eminent degree.

"We see in this grand hall an assemblage of chemists known by their earnest labours and valuable discoveries, and we are honoured by the presence of men of the highest distinction in other branches of science, as well as of leaders in the learned professions. It might not be unreasonable to believe that enthusiastic delight in the triumphs of chemical research is duly represented by some of the guests in this hall, and that the lively conversation which has been going on may not relate merely to high questions in jurisprudence, medicine, or legislation, but that some samples of chemical enthusiasm may reach the ears of the learned representatives of other professions.

"I feel sure that at a future time we shall all look back with the highest pleasure upon this delightful evening, which we owe to the kindly exertions of our President and other leading members of the Society."

Dr. John Hall Gladstone—"It is a pleasant thing to look on the faces of so many friends with whom one has worked in olden times, with whose works one is well acquainted. Though, of course, there are many at the present time who come into the Society, and whom I can look to as budding philosophers: unfortunately, I do not know their names so well as their faces. The pleasure is not merely because we call ourselves chemists, but because there is a bond of union between us arising from the desire of discovering the wonderful secrets of the great cosmos of which we ourselves form part. There is a great difficulty in speaking to you this evening, because so much that I should have liked to say has already been said by previous speakers. Still there are one or two things which, if you will permit me, I should like to bring before you. First of all, in your too flattering description of myself and of my work—which makes me rather ashamed to stand up and speak—there was a point which I think calls for remark, and so I must venture upon that which characterises the speeches of all of us, a certain amount of early autobiography. I was exceedingly fond of science from a little child. My favourite science was geology, and also what could be seen in the microscope—infusoria, and other little objects we have heard of in later times. But, in choosing a profession, my father said geology was not a promising career, and recommended chemistry. I knew very little about it, but went to University College and studied under that admirable teacher, Professor Graham, and afterwards under Liebig. I suppose it was from Graham that I acquired the taste for the physical side of chemistry and its connection with heat, light, electricity, and other forces of nature. I looked out for a scientific position, and lectured at St. Thomas's Hospital for some time, made analyses, and considered myself a professional chemist It may be that circumstances have caused me to sink into the position of an amateur chemist, but my first intention was that of following chemistry as my profession in life. It has not been necessary to continue that; and I have had this advantage, that I could always keep in my laboratory a good, trained assistant, and thus, whilst I was engaged in other works and ways, and in endeavouring to extend the knowledge of chemistry and elementary science in our primary schools, the work still went on more or less under my immediate direction. I should like to have said something about the progress of chemistry during these past fifty years; but the subject is so enormous, and you yourself have touched upon it to such an extent and so well, that I need only allude to the fact that this great change of volume of chemistry has caused it to be necessary that we should specialise. Specialisation has its advantages, but also its disadvantages. One danger is that we may become narrowed in our views. So it would appear to be best to have a home somewhere or other, but to make occasional excursions in the neighbourhood, and take summer holidays so as to get our nerves braced up to work again at our own pet subjects. I must not touch upon other points, such as the relations of the physical forces to chemistry, or its useful applications, and the great value of chemical research for the welfare of mankind. These are subjects too large and important to enter upon at this late hour. It seems to me that while we are always increasing the mass of knowledge we possess, the space which we see to be bright becomes larger and larger, but there is beyond a dim nebulosity. It is our work to bring from that nebulosity something into the bright space, so that it becomes the property of the human race. But there is beyond this a region which we do not understand—infinite as far as we know—and our object is to increase that which is knowable, in the firm belief that it will be for the advantage of our fellow creatures. While I feel thankful for the joy that I have had in taking some part in these discoveries, I cannot look to have much more time given me for carrying on this work of investigation; but still, there may be a few threads of old research I may gather up, and in doing so I shall be greatly encouraged by the kind remarks of this evening, and the way in which our work has been received by the friends gathered around us."

RECENT AND FOSSIL RHINOCEROSES.[1]

PROF. OSBORN'S palæontological work is so painstaking, and his material is so rich, that all interested in the study of the evolutionary and distributional history of those remarkable Peristodactyles which may be included under the general title of Rhinoceroses, cannot fail to welcome the appearance of the elaborate and well-illustrated memoir before us. As at present planned, the complete memoir is to consist of no less than seven parts, two of which are contained in the present issue; so that until the whole appears, a suspension of judgment in regard to many points is due to the author.

Prof. Osborn is of opinion that the Rhinoceros-like Ungulates may be divided into the three families of *Hyracodontidæ*, *Amynodontidæ*, and *Rhinocerotidæ*. And as this arrangement tallies fairly well with the date of appearance and disappearance, and also with the relative specialisation of its various members, the general principle may be adopted. It must not, however, be supposed that either of the first two families are exclusively ancestral types of the third, as many of their representatives tended to specialise at a comparatively early period, and took an evolutionary line of their own. Some, for instance,

[1] "The Extinct Rhinoceroses." By H. F. Osborn. *Mem. Amer. Mus Nat. Hist.*, vol. i. part iii., pp. 75-164, Plates XIIA-XX. (1898.)

developed into upland running types, which competed with the Horses and Ruminants of the plains; while others were more likely frequenters of marshes and river-banks, like many of the Rhinoceroses of the present day. Neither the Hyracodonts or the Amynodonts ever developed horns, and all the early species of true Rhinoceroses had weak, hornless nasal bones, so that in external appearance they were probably more like large-sized Tapirs than the well-armed animals with which we are now familiar.

"They did not interfere with each other," writes the author, "because each enjoyed a different local habitat while occupying the same general geographical regions. The Hyracodonts dwelt in the drier grassy plains. The Amynodonts frequented the river and lake borders. Up to the time of the extinction of these two related families, the true Rhinoceroses maintained a somewhat uniform structure, both in Europe and America, differing so far as we know in size rather than in proportions. Their dentition and their feeding habits were probably similar to those of the *R. bicornis* of Africa, and the *R. sumatrensis* and *R. sondaicus* of Asia, namely upon shrubs, leaves, and softer herbage. After the extinction of the rival families, however, there was naturally a tendency on the part of the true Rhinoceroses to enter the peculiar local habitats previously occupied by the Hyracodonts and Amynodonts, and they accordingly diverged into upland and lowland, short and long-limbed, brachydont and hypsodont types."

From this it will be evident that Prof. Osborn by no means confines himself to the dry details considered sufficient by so many palæontologists, but endeavours to give his readers a mental picture of the habits of the animals he so well describes. He next proceeds to show that the *Rhinocerotidæ*, or true Rhinoceroses, diverged into four sub-families. These are, first, the *Aceratheriinæ*, or Hornless Rhinoceroses; second, the *Diceratheriinæ*, or Transversely-horned Rhinoceroses; third, the *Rhinocerotinæ*, or typical Rhinoceroses; and, fourth, the *Elasmotheriinæ*, represented only by the huge *Elasmotherium* of Siberia. And he further shows that while the first and second of these, like the Hyracodonts and Amynodonts, are common to the Old and New Worlds, the third and fourth are exclusively Old World types.

In the New World the Rhinoceroses became entirely extinct at the close of the Miocene period; and this, although it is not mentioned by the author, is doubtless the reason they never penetrated into South America, which up to that date was cut off from North America. No reason can at present be assigned for the sudden extinction of the group in North America, seeing that a profusion of animals, adapted apparently for a warm climate, flourished there during the Pliocene; while the case of the Woolly Rhinoceros and the Elasmothere indicates that the Rhinoceroses themselves were capable of fitting themselves to withstand sub-arctic conditions.

Whether the group first originated in the Eastern or the Western Hemisphere, the author, perhaps wisely, refrains from discussing. In both regions they appear to have come into existence at approximately the same period; and in both, up to a certain stage, they seem to have undergone a parallel development. This, as in the case of the Horses, would seem to suggest that during the middle portion of the Tertiary epoch the connection between the Old and the New Worlds was much more extensive than a mere narrow bridge across Bering Strait. But, on the other hand, the existence of large groups like the Civets and Hyænas which never succeeded in travelling from the Eastern to the Western Hemisphere, is, so far as it goes, in favour of only a narrow connection in high latitudes.

As already mentioned, the author includes all the typical Rhinoceroses in a single sub-family or group. On p. 84 this group is correctly termed *Rhinocerotinæ*, but in the table on p. 121 it is renamed *Ceratorhinæ*, which is obviously wrong. As with the *Aceratheriinæ*, the author considers that the group may be divided into a Dolichocephalic and a Brachycephalic section. The former section is taken to include all the Pliocene and Plistocene Old World species, with the exception of the Pikermi *R. pachygnathus*; while the latter embraces the Miocene and recent Old World types, except the living *R. sumatrensis*. To this classification we must take one exception. In our opinion the African "White Rhinoceros" (*R. simus*) is as dolichocephalic as the Plistocene *R. antiquitatis*. The figure of the skull of the former, which the author has copied from some previous writer, is misleading; and if he had the opportunity of seeing the fine series of specimens in the British Museum, he would in all probability amend the statement.

Space prevents detailed notice of the interesting observations which the author gives on the evolution of the cheek-teeth in the group. It may, however, be observed that he is in accord with previous writers in regarding the white and woolly Rhinoceroses as presenting the culminating point of molar evolution among the typical Rhinoceroses; *Elasmotherium* representing a still more specialised offshoot by itself. At present we are left in some degree of doubt as to the author's views with regard to the generic or subgeneric divisions of the Plistocene and recent Rhinoceroses; but light will probably be thrown upon this point as the work proceeds. So far as they have been carried at present Prof. Osborn's labours afford, in the main, a distinct advance in our knowledge of a very interesting group, and the completion of his memoir will be anxiously awaited by all who have made the subject a special study. R. L.

THE BRITISH ASSOCIATION.

BRISTOL MEETING.

SECTION K (BOTANY).

OPENING ADDRESS BY PROF. F. O. BOWER, SC.D., F.R.S., PRESIDENT OF THE SECTION.[1]

II.

I. *Algae and Fungi.*

AT first sight those Algae and Phycomycetous Fungi which show a subdivision of the zygote appear to offer the key to the enigma of the first start of antithetic alternation, and such rudimentary fruit-bodies as those of *Oedogonium* and *Coleochaete* are frequently quoted as prototypes of sporogonia. My own position has been that they may be "accepted as suggestive of similar progress in the course of evolution of Vascular Plants." On the assumption that the zygote is equivalent in all cases—and this is itself a pure assumption—the fruit-body of such Algae or Fungi would be comparable to the sporophyte in higher forms; but it must be clearly remembered that it is not even then proved to be *homogenetic*. Dr. Scott has based a strong line of criticism of antithetic views upon these cases. He remarks: "The sudden appearance of something completely new in the life-history, as required by the antithetic theory, has, to my mind, a certain improbability. *Ex nihilo nihil fit.* We are not accustomed in natural history to see brand new structures appearing, like morphological Melchisedeks, without father or mother. Nature is conservative, and when a new organ is to be formed it is, as every one knows, almost always fashioned out of some pre-existing organ. Hence I feel a certain difficulty in accepting the doctrine of the appearance of an intercalated sporophyte by a kind of special creation."

In answer to this, I state that to me the zygote, from which our hypothesis starts, is not "nothing"; it is a cell with all the powers and possibilities of a complete cell. Vöchting, in his "Organbildung," has fairly concluded that "a living vegetative cell which is capable of growth has not a specific and unalterable function." I have myself demonstrated that cells typically sporogenous may develop as vegetative tissue, and conversely that tissues normally vegetative may on occasions become sporogenous. We may, therefore, say generally as regards the sporophyte, that "a living cell which is capable of growth has not a specific and unalterable function." This I conceive to have been the condition of the zygote, and of its early products.

I think that the words "intercalation" or "interpolation," as used by writers on antithetic alternation, have been quite misunderstood. I have contemplated no sudden development—indeed, on the first page of my "Studies" I have spoken of the sporophyte as "gradually" interpolated. Nor is the suggested development something "completely new," for I specially speak of elaboration of the zygote. This is the parent of these "morphological Melchisedeks"; and unless segmentation be held to be synonymous with "special creation," I confess I do not see where the initial difficulty arises. I agree that nature is conservative; what we contemplate is the fashioning of the sporophyte by a process of which the first step is segmentation, out of a pre-existing organ the zygote. Such simple segmentation is seen in the case of certain Algae and Fungi, and these may be taken as suggesting how the sporophyte of the Archegoniatae may have come to be initiated. But I am not aware of having ever suggested that these segmented zygotes of Algae are the homogenetic prototypes of the more elaborate sporophytes.

[1] Continued from p. 69.

Dr. Scott further states that "the reproductive cells produced by the ordinary plant of an *Oedogonium* are identical in development, structure, behaviour, and germination with those produced by the oospore." Prof. Marshall Ward, also speaking of *Œdogonium*, remarks "the attempt to get over this by terming asexual spores borne by the gametophyte *gonidia*, and reserving the term *spore* for bodies indistinguishable from these gonidia by any morphological or physiological character whatsoever, beyond their origin from a so-called sporophyte, carries its own refutation." Now, as a matter of fact, Pringsheim's description and figures of *Oedogonium* give scanty details; in most of the germinating zygotes the nuclei themselves are not clearly shown; much less the details of behaviour of those nuclei on germination. Klebahn has described the fusion of the sexual nuclei in *Oedogonium*, but I am not aware that he, or any one else, has yet made detailed observations on the nuclear condition of the zoospores, or the changes which take place in the germinating egg. Till this is done I submit that it is premature and undesirable to make such assertions as those of Dr. Scott and Prof. Ward. We now know that important nuclear changes do take place on the germination of the zygotes of certain Algae and Fungi. These changes are connected with a division of the nuclei into four, which is the number of the zoospores usually produced on germination in *Oedogonium*; the details may differ, but in the zygotes of *Closterium* and *Cosmarium*, and in the formation of the auxospores of *Rhopalodia*, Klebahn has demonstrated this division into four; also Chmielewsky has described a similar production of four nuclei in the germinating zygotes of *Spirogyra*. When it is further stated that in some of these cases there is good reason to think that a reduction of chromosomes is connected with the division into four, just as a reduction is now known to accompany the tetrad division in Archegoniate and Phanerogamic plants, it is plain that such cases as that of *Oedogonium* ought not to be assumed to support an homologous view without any fresh observation of the facts.

With the whole question of alternation, the nuclear details and differences in number of the chromosomes on division are now intimately bound up. Though the observations are still few, so far as they go they are consistent with the generalisation first stated by Overton, and elaborated by Strasburger as regards the Archegoniate and Phanerogamic plants. It has now been seen in cases drawn from various groups, that the cells of the gametophyte show a certain number (n) of chromosomes, while those of the sporophyte show on nuclear division double that number ($2n$) of chromosomes. Since Section K has had the advantage of a statement on this subject from Prof. Strasburger himself at Oxford, and as Dr. Scott also discussed the matter at Liverpool, I need not enlarge. I shall only remind you that Strasburger took up the position that the number of chromosomes which appears in each sexual nucleus is that original number which the ancestors possessed in a pre-sexual period; while the reduction of the double number which results from sexual fusion is, in his opinion, to be regarded as an atavistic process. As far as investigation has yet gone, I see nothing to prevent the acceptance of this as a provisional theory.

It is now well known, however, from the observations of Farmer and of Strasburger, that the nuclear conditions of *Fucus* are peculiar; that the reduction only takes place on the formation of the sexual organs themselves, and that the *Fucus* plant, like a sporophyte in the Archegoniate series, has the double number of chromosomes. At first sight this might appear to be a fatal difficulty, and Dr. Scott, attributing to the adherents of the antithetic theory views from which I personally dissent, has landed them in a seeming *reductio ad absurdum*. He himself does "not think we are as yet in a position to draw any morphological conclusions from these minute differences, interesting as they are." But we need not accept either of these extreme positions, if only a certain elasticity of theory be maintained, which should come naturally to adherents of polyphyletic development. I think the difficulty will chiefly be felt by those who, like some of the earlier writers on alternation, attempt to reduce all plants which show sexuality to one stiff scheme; this has been found to fail in the case of alternation, and a healthy recognition of various types of alternation has been the consequence. So in the matter of chromosomes, and of the position which the event of reduction holds in the life-cycle; difficulties such as this in *Fucus* may be anticipated, if we assume that all plants will conform to one plan. But Strasburger has not considered it necessary to cast aside the nuclear details as a basis for morphological conclusions, because all plants investigated do not fall in with a preconceived scheme. On grounds of comparison of behaviour of the nuclei before and after conjugation in *Closterium*, *Cosmarium*, *Spirogyra*, in certain Diatoms, and finally in *Actinophrys*, he has arrived at the conclusion "that a shifting (Verschiebung) of the time of division into four, together with reduction, is possible in the history of development of organisms." It will doubtless be necessary later to put a precise meaning upon the word "Verschiebung," and to define how far in given cases it is to be understood as an actual shifting of the event within one line of descent, how far it merely expresses an initial difference maintained, or it may be, extended, in different lines. Meanwhile, those who accept Prof. Strasburger's position will see that while in various evolutionary sequences the reduction may take place at different points in the cycle, still it may have settled down to a fixed and constant position in any one sequence; that I conceive to have been the case for the Archegoniate series. The validity of this conclusion does not seem to me to be affected by the diverse state of things seen in so far removed a sequence as that of the brown Algae.

Here a brief reference must be made to the very beautiful results of Wager on the changes in the zygote of *Cystopus candidus*, which have been verified and extended by Berlese. Wager states that in this fungus the process of fertilisation does not differ in any essential particular from the process as it takes place in Angiosperms. On the division of the fusion-nucleus of the zygote the number of the chromosomes present before division appears to be considerably in excess of the number observed in the nuclei of the oogonium. "By counting as carefully as possible 20 to 24 or even more appear to be present, and the impression is produced that the number is certainly much larger than that observed in the oogonium." Divisions of the nucleus then follow to form 4, 8, 16, and finally 32, in which condition a period of rest ensues; and finally, it appears that a division of each into four follows, to form the nuclei of four spores. Wager believes the reduction to take place at this last division, and Berlese has established a strong probability that such a reduction actually does take place. Plainly these observations are not final or conclusive, and even if they were, the strict homogeny of this fruit-body with a rudimentary sporophyte of a green plant would not be proved. It must, however, rank at least as an important parallel case, illustrating how the reduction may be effected in a distinct line of descent.

We see then that in green Algae such as *Oedogonium*, *Sphaeroplea*, and *Coleochaete*, certain divisions follow fertilisation, but we are not yet in possession of the nuclear details. I prefer, therefore, to suspend judgment as to the nature of those divisions; but in view of the peculiar behaviour already seen in other zygotes, it may be distinctly anticipated that some form of reduction will be demonstrated at that stage. If that be shown then we shall be right in recognising in these small cell-bodies the rudimentary correlative of a sporophyte—the sort of beginning from which a neutral generation may have sprung in land-living plants. We cannot go further than this as regards the green Algae until we are in possession of the facts. There is no greater desideratum in morphology at the present moment than a detailed knowledge of the germination of zygotes such as that of *Oedogonium*.

Here I may remark that the admirable observations of Prof. Klebs, whom the Section will welcome as a distinguished guest, do not appear to me to touch this question. His very varied and convincing experiments show in a number of Algae and Fungi that, as regards the succession of vegetative and sexual modes of propagation, the experimenter has a very complete control. I do not find, however, any observations of his which touch the behaviour of germinating zygotes of green Algae as regards details of segmentation. I do not mention this as in the least impairing the brilliancy of Prof. Klebs's work, but because Prof. Ward has brought Klebs's results to bear upon the discussion on antithetic alternation in a manner which I do not think that the facts will support.

II. *Bryophyta*.

Turning now to the Bryophytes, these plants stand at the moment in a somewhat discredited position. We have been warned by Dr. Scott that "there is no reason to believe that the Bryophyta, as we know them, were the percursors of the Vascular Cryptogams at all," and that "there is no appreciable resemblance between the fruit of any of the Bryophyta and the plant of any Vascular Cryptogam," and the suggestion has been

thrown out afresh that they may really be "degenerate descendants of higher forms."

In view of statements such as these it may be well to examine the Bryophyta quite separately, without reference to Vascular Plants at all, and see what are their main bearings on theories of alternation. And if the Bryophytes were the only Archegoniate Plants in the world, I think the case for their origin by a progressive antithetic alternation would be an uncommonly strong one; the points which are especially noteworthy are: (1) The readiness with which they may be arranged in natural sequences which illustrate increasing vegetative complexity of the sporophyte as a consequence of progressive sterilisation; (2) The nuclear details, which are as yet known, however, in only few cases; (3) The constancy of the two alternating phases, the relations of which are very seldom disturbed by apospory, and never, to my knowledge, by apogamy.

The first of these matters has been dealt with at length in my "Studies." It is, of course, possible for any one to read such sequences as are there mentioned in reverse order, and to uphold a theory of simplification; but this must be shown to be in accordance with probability. Now it appears to me that the general probability in the case of the Bryophytes is against simplification, for the larger the number of spores which can be matured the greater the probability of survival; even in cases where, as in *Buxbaumia* and *Diphyscium*, there is an exiguous, and probably reduced Moss-plant, the sporogonium is not of a reduced type, but, on the contrary, unusually large. It seems to my mind much more probable that the Bryophytes as a whole illustrate a course of progressive complexity. A comparison of anatomical details frequently suggests a progressive sterilisation, a process which we see demonstrated both in Pteridophytes and Phanerogams, where actual conversion of potentially sporogenous tissue into temporary or permanent vegetative tissue does occur. When it is added that the nuclear evidence, scanty though it still is, shows the sporophyte with a double number of chromosomes, and the reduction taking place on the tetrad division of the spores, the comparison with the segmented zygotes of Algae and Fungi above mentioned seems inevitable. The position of those who hold views of antithetic alternation will, therefore, be that the simple sporogonium was produced as a post sexual growth. The starting-point was probably some such multicellular body as we see nowadays in certain Algae and Fungi resulting from division of the zygote, but not necessarily homogenetic with any such body that we know now living. The land habit imposed a restriction on fertilisation, and an alternative method of increase in numbers was an advantage. The multicellular body resulting from division of the zygote provided the means for this; the cells developed separately as dry, dusty spores. As the number of divisions increased, the powers of the plant to nourish, protect and disseminate the spores became the measure of the number produced. Hence followed the elaboration of the nourishing and disseminating mechanism, which has involved a diverting of some cells from their first office of spore-production, the start being, perhaps, made in a manner similar to the formation of the peridium in the Uredineæ. To my mind—taking the Bryophyta alone—there is an inherent probability in all this, which far counterbalances any of the obstacles which have been raised against it.

The greatest obstacle is the fact of apospory in Mosses. This departure from the usual alternation will be more generally discussed in relation to the Ferns, where it is more frequent. Besides its being artificially induced in Mosses by special treatment, it appears also to have been noted by Ugo Brizi in nature, in the case of atrophied capsules of *Funaria*, which had buried themselves in the soil. The essential point is the production of the sexual generation by direct vegetative growth from the neutral. This would appear to involve a reduction of chromosomes, but Pringsheim's drawings show nothing analogous to the usual process of tetrad division to form the spores; the reduction, if it occurs, must be effected in some other way.

A theoretical suggestion on this point will be made later. Meanwhile let us estimate its probable importance as regards the Bryophyta. It cannot fail to strike the observer how uniform is the alternation in these plants; there are, I believe, no recorded cases of deviation from the normal alternation in Liverworts. I know of only a single case of apospory among Mosses taken in the open, and then in atrophied capsules; apospory, when induced, follows such extreme treatment as chopping the sporogonium into pieces. And it is not as if the Mosses and Liverworts had escaped detailed observation; hardly any group of plants had been more carefully examined by competent observers. Deviations from strict alternation then are rare, and appear under physiological stress. This great group, which includes the simplest sporophytes among Archegoniate plants, is also singularly constant in its alternation. I think this is to be connected with the permanently dependent condition of the sporophyte; its equable physiological condition, nursed and protected by the Moss plant, finds its morphological expression in its comparative uniformity. Conversely the independent position of the sporophyte in Ferns, and its exposure to varied conditions may have elicited more freely in them unusual developments.

III. *Abnormalities.*

And now I may pass to my third point, and discuss more generally the argument from abnormalities. I have no wish to prejudge the question by the use of this term as applied to apogamy and apospory, or in any way to detract from their morphological importance—I merely intend to express that they are departures from that order of events which is the most frequent in Archegoniate plants at large, and I particularly wish to point out that while such irregular developments are now shown to be frequent in Ferns, they are exceedingly rare in Bryophytes, and are not, I believe, hitherto recorded for Lycopodineae or Equisetineae.

While direct vegetative transitions from one generation to the other may appear as a *primâ facie* support of an homologous origin of the two generations, I must protest against their being used, as they have been, as evidence against an antithetic view. It has been said that the facility with which these transitions from one generation to another in Ferns take place "shows that there is no such hard and fast distinction between the generations as the antithetic theory would appear to demand." Why should it demand a hard and fast distinction? For my own part, I had already described apogamy and apospory as occurring in the same individual before I wrote on alternation. The presumption seems to be that a distinct course of evolution must have imposed "hard and fast" limits upon the potentialities of the parts evolved. But we ought to remember how the root, whether in Phanerogams or Ferns, has doubtless had a long course of evolution as a member distinct from the shoot; and yet we see it bearing adventitious buds upon it, as in the Rosaceae, Poplar or Elm; or even transformed at its apex into a shoot, as in *Platycerium* or *Anthurium*. Such cases as these, though not exact parallels, should suffice to show that hard and fast lines are not to be anticipated as a consequence of a distinct course of evolution.

There is another kindred, though almost converse, proposition which has been advanced by Pringsheim. He made his experiments on Moss fruits, "in the hope that he would succeed in producing protonema from the subdivided seta of the Mosses, and thus prove the morphological agreement of seta and Moss-stem." The point here appears to be that parts which are capable of producing similar growths are in "morphological agreement." I cannot assent to this proposition. In the case of the roots above quoted, the production of buds upon them, or the conversion of their apices into shoots, does not prove their "morphological agreement" with shoots upon which such developments are common.

By those who use such arguments it is to be borne in mind that the two generations, however distinct in their evolution, are still merely stages in the life-history of one and the same organism. The hereditary qualities of the race as a whole must be transmitted through the successive generations. It may be a question how far, and under what conditions, its various potentialities come into evidence, as, for instance, in the formation of an apogamous sporophyte, or of an aposporous protonema; but that some such potentialities are there is in no way inconsistent with the antithetic theory.

I have above pointed out how morphology has recently passed to an experimental stage, and I am glad to say that by means of the cultures of Dr. Lang and others we are beginning to gain an insight into the circumstances which lead to these phenomena. In certain Ferns direct apogamy occurs: that is, "the immediate production of vegetative buds by prothalli which are usually incapable of being fertilised"; the origin of this is still obscure. But apogamy may also be induced in various other species. Dr. Lang states that "the causes which appeared to induce apogamy in these prothalli were, the prevention of contact with fluid water, which rendered fertilisation impossible, and

the exposure to direct sunlight. Possibly the temperature had some effect." It is further to be noted that in every case of induced apogamy "normal embryos were produced when conditions permitted fertilisation." Now the conditions of prevention of fertilisation, exposure to light, and possibly also a high temperature, all lead to a plethoric state, which we may thus recognise as a precursor of induced apogamy, possibly also of apogamy at large.

On the other hand, the circumstances which precede or accompany apospory are commonly those of deficient nutrition. In the case of Ugo Brizi's *Funaria*, it is mentioned that the capsules were atrophied and buried in the soil, where they could not obtain nourishment by their own assimilation. In the induced apospory of Stahl and Pringsheim the growths appear upon parts of the chopped up seta, isolated from their usual sources of supply. Among Ferns, the conditions of nutrition which precede apospory have not been noted in all cases; but the following facts are interesting. *Athyrium Filix-foemina* var. *clarissima* is a pale chlorotic Fern with exiguous leafage, while the more or less complete arrest of the sporangia is a concomitant of apospory. In *Polystichum angulare* var. *pulcherrimum* there is no obvious disturbance of the vegetative organs, but I have specially noted the sporal arrest, which, in the specimens examined by me, appeared to be complete. This is, then, a concomitant of apospory, though it may be uncertain how far there is a casual connection. In the case of apospory in *Pteris aquilina*, reported by Farlow, there is an irregular diminution of leaf-area in the pinnules which show apospory; this is accompanied by various stages of abortion of the sporangia, though some fully-matured spores were found. Here, as also in *Polystichum angulare*, the tips are specially affected. Farlow remarks, "the sporangia became more and more irregular the nearer they were to the tip." In the case of *Scolopendrium vulgare*, the plants which showed apospory at so peculiarly early a stage had been raised by Mr. Lowe from prothalli which had been repeatedly divided, a process calculated to affect the physiological condition. The aposporous plants of *Trichomanes alatum*, *pyxidiferum*, and *Kaulfussii*, were all cultivated under artificial conditions, and are characteristically shade-loving plants, a habit which must affect their nutrition. Perhaps the most interesting case, however, is that described by Atkinson in *Onoclea*. In plants from which, by removal of the foliage leaves, the sporophylls had been induced to change their character and develop as foliage leaves, the sori were arrested. "When the leaf has lost so much of its reproductive function that the sporangia are becoming rare or rudimentary in the sorus, apospory frequently occurs, and the placenta develops among the rudimentary sporangia prothalloid growths." Here is, again, a case of deficient nutrition; the assimilating leaves, after formation, but before they could have carried their functions far, were removed. The plant makes an effort to supply their place at the expense of spore-production; arrest of sori and sporangia is the result, accompanied by cases of the direct vegetative transition to the prothallus. From these examples we see that deficient, or, at least, disturbed nutrition is frequently, perhaps always, a concomitant of apospory. Thus there is some countenance for the view that apospory and apogamy follow on converse conditions of nutrition.

We may next inquire how these converse conditions may lead to the changes in question; and especially the state of the nuclei ought to be considered. Owing to practical difficulties of observation the behaviour of the nuclei in apogamy and apospory has not been directly followed. But if the nuclear difference between the two generations be as it is believed, nuclear changes will be closely connected with these vegetative transitions. What could appear more natural than that apogamy, which presumably involves a doubling of the chromosomes, should follow a condition of plethora, and that apospory, which presumably involves a halving of the chromosomes, should follow deficient nutrition?

One further fact in either case appears to me to be specially noteworthy, that the changes are not confined to a single cell. The directly apogamous bud of *Nephrodium Filix mas* may perhaps be referable to a single cell, but Dr. Lang shows by numerous examples that the transition from characteristic tissue of the gametophyte to that of the sporophyte may arise at various points, and involve considerable tracts of tissue. Similarly I have shown in the case of apospory that the change may affect not one cell only, but cell-groups at various and distinct points on the same individual. It would seem that there is a widespread disposition of the tissues to undergo the change.

For my own part, I think the usual attitude on the chromosome question has been too absolute and arithmetical. Evidence is accumulating from various sources that the usual numbers are not strictly maintained; it is known that in vegetative cells there are often considerable differences of the number of chromosomes from those in the sexual cells of the same plant, while observers have noted the irregularities in the divisions of the pollen mother-cells in such plants as *Hemerocallis* and *Tradescantia*. If there be any causal connection between the number of chromosomes and the morphological character of the sporophyte and gametophyte, irregularities such as these at least countenance the idea of nuclear instability being possible; it will be a question for special treatment and investigation how far nuclear instability is connected with disturbed nutrition. But into the mechanism of the presumable nuclear change, and the question whether it be sudden or gradual, we cannot enter with any more than a speculative interest, in the absence of direct observations. Whatever the nuclear details may be, I regard it as a matter of very great importance to recognise that special conditions of nutrition commonly accompany, if indeed they do not actually determine, those changes which we term apospory and apogamy. But the story of the past is not simply a matter of conditions of nutrition, as we see them now influencing Archegoniate plants in their present highly specialised state. The real question is a purely historical one, How *did* the present state of things come about?

(*To be continued.*)

THE TEACHING OF SCIENCE IN ELEMENTARY SCHOOLS.[1]

YOUR Committee are able to report that the quantity, if not the quality, of the teaching of science subjects in elementary schools has made progress during the past year. The following table, made up from the return issued by the Education Department, gives the figures for the scientific class subjects as compared with English. In the report for last year it was mentioned that the number of school departments taking object lessons would greatly increase, as the Government code of regulations announced that they would become obligatory in the three lower standards on and after September 1, 1896. We now see the result, so far as the schools are concerned whose school year ended between August 31, 1896, and August 31, 1897, but the full effect cannot appear until the next year's return, the whole of which will be in the obligatory period.

Class Subjects — Departments	1890–91	1891–92	1892–93	1893–94	1894–95	1895–96	1896–97
English	[illegible]	18,175	17,394	17,032	[illegible]	[illegible]	[illegible]
Geography	12,806	13,485	14,256	[illegible]	15,702	[illegible]	[illegible]
Elementary Science	173	788	1,073	1,215	[illegible]	[illegible]	[illegible]
Object Lessons ...	—	—	—	—	—	[illegible]	[illegible]

The number of departments in "schools for older scholars" for the year 1896–97 was 23,080, all but 10 of which took one or more class subjects. But history was taken in 5133 departments, and needlework (as a class subject for girls) in 7397 departments, and sundry minor subjects in 1056, making, with the other four subjects of the table, a total of 55,456. This shows an average of more than 2½ class subjects to each department; but it must be borne in mind that the same subject is not always taken in all the standards, in which case three class subjects will appear in the return.

It was remarked in the last report that "the increased teaching of scientific specific subjects in the higher standards is the natural consequence of the greater attention paid to natural science in the lower part of the schools." The following table shows the correctness of this inference:

[1] Report of the Committee consisting of Dr. J. H. Gladstone (Chairman), Prof. H. E. Armstrong (Secretary), Prof. W. R. Dunstan, Mr. George Gladstone, Sir John Lubbock, Sir Philip Magnus, Sir H. E. Roscoe and Prof. S. P. Thompson. (Read before Section L of the British Association at the Bristol Meeting.

Specific Subjects—Children	1891–92	1892–93	1893–94	1894–95	1895–96	1896–97
Algebra	28,542	31,487	33,612	38,237	41,846	47,225
Euclid	927	1,279	1,399	1,468	1,584	2,059
Mensuration...	2,802	3,762	4,018	5,614	6,859	8,619
Mechanics	18,000	20,023	21,532	23,806	24,956	26,110
Animal Physiology	13,622	14,060	15,271	17,003	18,284	19,989
Botany	1,845	1,968	2,052	2,483	2,996	3,377
Principles of Agriculture ...	1,085	909	1,231	1,196	1,059	825
Chemistry	1,935	2,387	3,043	3,850	4,822	5,545
Sound, Light, and Heat ...	1,163	1,168	1,175	914	937	1,040
Magnetism and Electricity	2,338	2,181	3,040	3,198	3,168	3,431
Domestic Economy	26,447	29,210	32,922	36,239	39,794	45,869
Total	98,706	108,434	119,295	134,008	146,305	164,089

It appears that the mathematical subjects still command the most favour on the part of the teachers, algebra having taken a very remarkable lead. All the physical sciences have increased even more than might have been expected from the increase of scholars. The principles of agriculture is the only subject that shows an actual decrease.

Estimating the number of scholars in Standards V., VI., and VII. at 615,000, the percentage of the number examined in these specific subjects, as compared with the number of children qualified to take them, is 26·6; but it should be remembered that many of the children take more than one subject for examination. The following table gives the percentage for each year since 1882, and shows that science is gradually recovering from the great depression of about eight years ago:—

	Per cent.		Per cent.
1882–83	29·0	1890–91	20·2
1883–84	26·0	1891–92	19·7
1884–85	22 6	1892–93	20·2
1885–86	19·9	1893–94	20 9
1886–87	18·1	1894–95	22·7
1887–88	16·9	1895–96	24·2
1888–89	17·0	1896–97	26 6
1889–90	18·4		

The Returns of the Education Department here given refer to the whole of England and Wales, and are for the school years ending with August 31. The statistics of the London School Board are brought up to the year ending with Lady Day, 1898. They also illustrate the great advance that has been made in the teaching of elementary science as a class subject, and they give the number of children as well as the number of departments.

Years	Departments	Children
1890–91	11	2,293
1891–92	113	26,674
1892–93	156	40,208
1893–94	183	49,367
1894–95	208	52,982
1895–96	246	62,494
1896–97	364	86,638
1897–98	322	70,626

The last year shows an apparent falling-off in the teaching of this subject, but, as has been mentioned above, the Government having made the giving of object lessons obligatory in the lower standards, 442 departments, with 75,993 children, have already adopted them. This has caused a reduction in the teaching of "Elementary Science" under that name; but, taking the two subjects together, this must be regarded as a very considerable gain.

The Education Department continues to meet the objection against the limitation under the Code by which only two class subjects are allowed to be taught, by adding combined courses of study. This year a new course of this character has been introduced into Schedule II, described as "Elementary Science and Geography Combined." And as, under the present regulations, one of the class subjects must be such as can be taught by means of object lessons in the lower standards, some such subject as the combined one above mentioned must be taken. A copy of the scheme is given in the Appendix, by which it will be seen in the lower standards the phenomena of the land and water are to be illustrated experimentally as an introduction to geographical science.

A similar principle has been adopted in respect of the specific subjects. Hitherto chemistry has formed a course of itself, and physics has been divided into two separate courses, the one dealing with sound, light, and heat, and the other with magnetism and electricity; but they formed only three out of the nineteen subjects from which choice could be made. A separate course of elementary physics and chemistry combined has now been introduced, which is set out in the Appendix, and which is admirably adapted for experimental investigation at the hands of the students themselves.

The work under the Evening Continuation Schools Code continues to progress, as will be seen from the following table:—

Science Subjects	Units for Payment							
	England and Wales				London School Board			
	1893–4	1894–5	1895–6	1896–7	1893–4	1894–5	1895–6	1896–7
Euclid	595	1,086	1,648	2.270	10	29	7	—
Algebra	3,940	6,657	10,374	14,260	316	302	535	714
Mensuration ...	14,521	32,931	41,772	50,748	279	374	452	36[illegible]
Elementary Physiography	2,554	4,045	6,590	6.325	37	9	5	—
Elementary Physics and Chemistry ...	6,500	7,850	6,749	5,183	79	200	152	12[illegible]
Science of Common Things	6,223	10,350	12,906	18,293	231	262	468	55[illegible]
Chemistry ...	3,484	7,814	8,222	9 641	212	455	404	48[illegible]
Mechanics ..	841	1,148	1,458	2,196	230	197	209	12[illegible]
Sound, Light, and Heat ...	500	1,046	861	1.156	—	15	11	[illegible]
Magnetism and Electricity ...	2,359	4,451	5,073	6,990	662	776	783	93[illegible]
Human Physiology...	5,695	8,395	7,825	10 047	91	68	56	4[illegible]
Botany	336	547	905	1,080	5	91	97	32
Agriculture ...	3,579	4,991	4,694	4.061	—	—	—	—
Horticulture ..	438	1,140	1,812	1,911	—	—	—	—
Navigation ...	42	69	142	99	—	—	--	—
Totals ...	51,607	92,520	111,031	134,260	2,152	2,778	3,179	3,410

It is again evident that the mathematical subjects are rapidly increasing in favour, and that agriculture is decreasing. It will be noticed with satisfaction that the science of common things is receiving greatly increased attention, but it is a matter of regret that there is a decrease in the time given to elementary physiography, and still more so in the case of elementary physics and chemistry. Agriculture would become a more valuable and probably a more popular subject of study if a really good practical course were devised.

An important change has been taking place in Scotland. The Code of the Scotch Education Department now admits of the possibility of gaining the full class grant, although only two subjects are taken. As one of these must be English, and in the higher standards provision must be made for history or geography or both, the teaching of science as a class subject has been greatly reduced during the last two years. But a new article in the Code for 1895 offers a special grant of a shilling on the average attendance of boys who are satisfactorily taught "elementary science"; and this has far more than made up the deficiency. In fact the aggregate total of children learning elementary science in the Scotch schools has risen from 34,151 in 1894-95 to 85,671 and 133,855 respectively in the two succeeding years.

Your Committee have frequently referred to the anomaly that pupil teachers are not obliged to receive any instruction in natural science, although they may have to give instruction in such subjects, either specifically or in the form of object lessons; indeed, if they should be in charge of a class of the three lower standards it would be obligatory upon them to give such object lessons. A Departmental Committee, consisting of the Rev. T W. Sharpe, Her Majesty's Chief Inspector of Schools, as Chairman, and several Inspectors and Principals of Training Colleges and Pupil-teacher Centres, have reported upon the pupil-teacher system. They recommend that the age for entering as pupil teachers should be raised, and that the interval between the elementary school and their apprenticeship should be passed at a secondary school. This would by no means ensure that the young people would receive any instruction in science during that period of their career. No alteration is proposed

in the optional science course prescribed by the Code of the Education Department, except that the Queen's Scholarship examination is to be limited to the elementary stage of physiography prescribed in the syllabus of the Science and Art Department. With regard to the college course the recommendation is singularly weak, science being placed as an optional subject, without any definite course of study prescribed. For the first two years it is laid down that of the optional subjects not more than two must be taken out of a list of four or six respectively, some of which from their very nature are almost sure to be taken in preference.

An important letter has been addressed to the Right Hon. Sir John Gorst by Sir Philip Magnus, the Chairman of the Joint Scholarship Board, in conjunction with the Chairmen of its four educational committees. They point out the necessity of securing the proper training of those who will be teachers of scientific subjects, and that the instruction of pupil teachers in science is now often carried on, under great pressure, by a system of cram, and even by persons who have not themselves any satisfactory knowledge of modern scientific methods. They suggest as a remedy that the first part only of the elementary stage, physiography, be compulsory; that the teaching of this subject be recognised only where it is given with proper accessories, all pupils performing the experiments in a series of at least twenty-four lessons of two hours' duration; and that inspectors should be required particularly to report whether proper apparatus and accessories are provided.

In last year's report your Committee referred to what Mr. Heller was doing in respect of the teaching of science in the schools of the London School Board. He has since obtained a better appointment at Birmingham, but the syllabus of lessons which he prepared is still employed in the schools. This of course requires that the masters and mistresses should be qualified for carrying it out, and for this purpose classes of twenty-four hours are conducted for their benefit by the science demonstrators. These gentlemen have lately agreed upon two separate syllabuses for masters and mistresses, which follow in general the scheme they are expected to teach to their scholars. The classes of a similar kind that have been carried on hitherto have been appreciated by the teachers, and the Board are increasing their laboratory and other accommodation for the purpose. It is recognised that it will be necessary to continue these teachers' courses for some years, in order to overcome the difficulty which now exists in consequence of the general want of practical experiment in such instruction in science as has been given in the course of training of most class teachers.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 194th meeting of the Junior Scientific Club was held in the Physiological Lecture Room of the Museum at 8 p.m. on Wednesday, November 16. After the election of new members, Mr. A. F. Walden (New College) brought forward his motion respecting the appointment of a Committee to act with the Treasurer of the Robert Boyle Lecture Fund. The motion was carried, and the Club elected Mr. A. E. Boycott (Oriel) and Mr. A. S. Elford (St. John's) to serve on the Committee. Mr. A. D. Darbishire (Balliol) read a paper on natural selection among Lepidoptera. His remarks were illustrated by several cases of butterflies. Mr. J. E. Marsh (Balliol) followed with a paper on the constitution of camphor, in which he attempted to survey all the recent work on the subject.

MR. ERNEST WILSON has been appointed professor of electrical engineering at King's College, London, in succession to the late Dr. John Hopkinson.

DR. GIUSEPPE SANARELLI, of the Uruguayan Medical School and Director of the Hygienic Institute at Montevideo, whose discovery of the microbe of yellow fever has brought him much distinction, has, the *Lancet* states, been offered by Dr. Baccelli (Minister of Public Instruction) the chair of Hygiene in the University of Bologna, left vacant by Prof. Roncati.

THE two first formal steps towards the establishment of a Midland University, to be called the University of Birmingham, were taken on Friday last, at a meeting of the Court of Governors of Mason University College. In reference to the scheme, the Management Committee reported that, in their opinion, the University to be established in Birmingham should be a teaching University, as distinguished from a University which only examines students for degrees. The University should therefore have the control and direction of all the teaching as well as the examining of students. With this end in view the Committee recommend that, if an agreement can be made with the governors of Mason University College, the University should be allowed to absorb the college. In this case the college would cease to exist as a separate institution, and its endowments, buildings, equipment, and staff would be transferred to the University. The Committee have had under consideration the financial position of the University. They are of opinion that, in order to completely carry out the above scheme, an endowment of not less than 200,000*l*. is required beyond that already held by Mason University College. Such an endowment would just double the present endowment of the college. The Committee expressed their opinion that every effort should be used to at once increase the endowment fund in order that an endowment of not less than 200,000*l*. may be obtained to enable the University to start under favourable conditions.

Mr. Chamberlain moved the two resolutions, one recommending that steps be taken to absorb and include Mason College in the new University; and the second, authorising the Council of Mason College to take the necessary measures to obtain a Royal Charter for the establishment of the University. In presenting these resolutions Mr. Chamberlain remarked: "I think our ideal may be stated in a few words to be the creation in Birmingham of a great centre of universal learning, of an institution which should provide for the intellectual cultivation of mind in the broadest possible sense, and which shall maintain for ever in the city the highest standard of intellectual eminence. We desire that in this school all acquired knowledge should be taught and explained, and we further desire that knowledge should be advanced by original research, and by the willing co-operation of those who are engaged as professors and teachers. The enormous development of science requires undoubtedly an extended application of the means of instruction. Of course, there is special reason why science should take a very prominent place in connection with a University which is situated in the centre of a manufacturing and commercial district, and it would, in my opinion, be pedantry were we to pretend that we did not attach the highest importance to this branch of our work, and did not intend that it should be distinctly carried out and should give to the University a special position of its own."

REFERRING to the address delivered by Mr. Chamberlain on the subject of a University of Birmingham, and referred to above, the *Times* remarked on Monday: "Those who carefully study German commercial methods are well aware that the chief cause of German success at the present time is the German manufacturers' respect for science. There is at the present moment at Düsseldorf a chemical company which employs thirty-three trained chemists, picked University men, who are paid good salaries with a share of the profits due to any invention which they may make; this company pays very high dividends, and its business has increased by leaps and bounds. It would be interesting, but not encouraging, to learn what has been the parallel history of the chemical works on the Tyne. This points to one way in which a Birmingham University, properly equipped, worked and encouraged, may affect the commercial prosperity of the city."

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No 10.—Gravitational constant and mean density of the earth, by F. Richarz and O. Krigar-Menzel. The gravitational constant, *i.e.* the constant which has to be inserted in the equation for determining the attraction from the product of the masses and the inverse square of their distance apart, when C.G.S. units are chosen, was found by the method of weighing a mass at two different altitudes above the earth's surface. The result arrived at was $6{\cdot}685 \times 10^{-8}$. The value for the mean density of the earth was $5{\cdot}505 \pm 0{\cdot}009$.—Surface tension in narrow capillary tubes, by P. Volkmann. When measurements are made on freshly-drawn capillary tubes, the results are well in accordance with the known laws, whatever the substance and diameter of the tubes. In old and wide tubes the surface tension is higher

by 0·02 mgr./mm., probably owing to the absence of solubility of the substance of the older specimens of glass.—A method for determining the thermal conductivity of solids, by F. A. Schulze. A rod of the material examined is at the temperature of the room. At a short distance from one end a thermo-couple is inserted. From a given instant, the end surface is exposed to a stream of water at a different temperature. Knowing the specific heat of the body, the author works out in detail an equation for finding the thermal conductivity, and illustrates it by examples which show a maximum error of 4 per cent.—Specific heats of metals at low temperatures, by U. Behn. If the decrease of the specific heat with the temperature is represented graphically, it appears probable that all the curves intersect at the temperature of absolute zero. At that temperature it is also possible that the specific heats themselves are zero. In any case, Dulong and Petit's law does not hold for low temperatures.—Coherers, by E. Aschkinass. The theory of the coherer according to which the decrease of resistance is accounted for by sparks which weld the particles temporarily together, does not suffice for the case of peroxide of lead, where the resistance increases under the influence of electric waves. The coherer action pure and simple is only observed under feeble electric radiation. When the latter is strong, disturbing influences supervene. Electrical and thermal measurements made on discharge tubes, by E. Wiedemann and G. C. Schmidt. When the appearance of discharge tubes is similar, whether they are fed by an influence machine or a continuous current, it is safe to assume that the potential gradients are the same. The values of the potential gradient as derived from probes and from calorimetric measurements respectively are the same, but the latter method is more suitable when the discharge is discontinuous.

Bollettino della Società Seismologica Italiana, vol. iv., 1898, Nos. 2, 3.—Echo in Europe of the Indian earthquake of June 12, 1897, by G. Agamennone. Seismoscope with multiple effect, by A. Cancani. The earthquake of Grandson [February 22, 1898], by F. A. Forel, a paper (in French) describing a series of short waves, about half a metre in height, which were observed on the lake of Neuchâtel at the time of this earthquake.—On the various systems of registration in seismology, by A. Cancani.—On the Rieti earthquake of June 28, 1898, by G. Brucchietti. An account of the damage caused by this earthquake at Rieti and elsewhere.—Notices of earthquakes recorded in Italy (July 27–September 17, 1897), by G. Agamennone, the most important being the earthquakes of Japan on August 4–5, Turkestan on August 15 and September 17, and Tuscany on September 6, and earthquakes of unknown, but distant, origin on August 6, 13, 16, 20 and 26.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, November 2.—Mr. G. H. Verrall, Vice-President, in the chair.—Mr. Merrifield exhibited some *M. aurinia* from Touraine forced and cooled as pupae, the latter being much the darker and more strongly marked, some *E. cardamines* from Sussex, those cooled having the apices of the wings darker and the discal spots smaller than those which have been forced, and some *C. edusa* from eggs laid by two normal females taken in Savoy, two out of the five reared being of the var. *helice*; the marginal border of one male, which had been forced, was very pale and much suffused with long yellow scales. He also showed four *P. machaon*; two of them, forced as pupae, had their dark parts very pale and their tails long and slender, the two which had been cooled having the dark parts much extended in area and darkened in hue, their tails being short and broad. These results, which were to be obtained with winter as well as summer pupae, corresponded with those previously obtained by Dr. Standfuss.—Mr. J. J. Walker exhibited two winter nests of *Porthesia chrysorrhoea* from the Isle of Sheppey, where the species had lately become very common.—Dr. Mason exhibited a Buprestid larva found among Baltic timber at Burton-on-Trent. This had been among wood in a box since the beginning of July last, and there was scarcely a trace of frass. Marsham had recorded the escape of a larva of *Buprestis splendens* from the wood of a desk in the Guildhall, which had stood there for more than twenty years. It is probable that the growth is extraordinarily slow, and consequently that the larva can maintain life for very long periods in most unfavourable conditions.—Mr. Blandford called attention to similar cases which he had brought before the Society. It appeared likely to him, from what was known about such insects as *Callidium variabile*, which was occasionally bred from dry wood at long intervals, that these species were not abnormally slow-growing under normal conditions, but became so in dry timber, in which they probably sustained life with difficulty, especially when the outside of the wood was varnished.—Mr. Waterhouse exhibited for Mr. G. W. Kirkaldy living examples in various stages of a *Caryoborus* in nuts of *Attalea funifera* from Brazil. Elditt had described the attacks of an allied species upon the seeds of *Cassia fistula*.—Mr. Tutt exhibited for Dr. Chapman a series of Swiss examples of *Zygaena exulans*, and discussed the differences between them and the Scotch form.—Papers were communicated by Mr. W. F. H. Blandford on some Oriental Scolytidæ of economic importance with descriptions of five new species, and by Mr. van der Wulp (through Colonel Yerbury) on Asilidae from Aden and its neighbourhood.

Linnean Society, November 3. Dr. A. Günther, F.R.S., President, in the chair.—The President exhibited an abnormal twin tusk of an adult Indian elephant, and made the following remarks. The tusk occupied the right jaw of the animal. The two teeth were developed from separate papillae and remained perfectly separate, without any connecting ossification, although they grew side by side from the same socket, the uneven surface of one closely fitting into that of the other. He was inclined to look upon the smaller tooth as a persistent milk-tooth, which, not being shed, continued to grow from its original papilla; but Mr. Charles Tomes, F.R.S., considered it a case of duplication, such as is sometimes found in man and other mammals, in which the development of two separate papillae gives rise to a twin tooth of the permanent dentition. No such case seems to have been previously observed in the elephant.—Prof. G. B. Howes, F.R.S., exhibited some young and six living eggs of the New Zealand lizard *Sphenodon* (*Hatteria*), received from Prof. A. Dendy, of Christchurch, N.Z., part of a full series which had furnished that gentleman with material for a monograph on the general development of the animal, now in course of publication. Briefly referring to the previous attempt of Parker and Thomas to secure material for the study of this subject, he said that the palaeontological discoveries of Credner justified us in regarding the Rhyncocephalia as the most central among terrestrial vertebrata. He remarked that the specimens had been sent him for the express purpose of working out the development of the skeleton. Recapitulating the more salient discoveries recently announced by Prof. Dendy in his preliminary paper in the *Proc. Royal Soc.* and elsewhere he said, in comment upon them, that the plugging of the nostrils by cellular tissue during development is a phenomenon already described by the late T. J. Parker in *Apteryx*, and that it appeared to him akin to that of the occlusion of the oesophagus of the vertebrate embryo first described by Balfour, which De Meuron had sought to associate with the metamorphosis of the branchial diverticula. He pointed out that Dendy's discovery of a third pair of incisors was confirmatory for the upper jaw of the conclusions of the late Dr. G. Baur, and remarked that he had received a letter from Prof. Dendy, dated September 12, stating that he and his colleagues at the Antipodes had secured a Government order protecting the eggs as well as the young of *Hatteria*.—Mr. A. F. Crossman exhibited some photographs illustrating the case of a chicken hatched and reared by a common buzzard. The buzzard had laid an egg in captivity, and manifesting a desire to incubate, a hen's egg was substituted, which in due course was hatched and the chicken reared, the foster-parent feeding it upon morsels of flesh. It thus appeared that in a conflict of instinct, under altered conditions of life, the maternal instinct had proved stronger than the natural impulse to kill and devour weaker prey. Mr. J. E. Harting remarked that the case was not an isolated one, instances of buzzards rearing chickens having been previously recorded (*Zool.*, 1881, p. 103), as well as several cases of eagles hatching goose-eggs and rearing the goslings (NATURE, April 1879, and *Field*, February 1896). Messrs. H. and J. Groves exhibited specimens of *Nitella hyalina*, Agardh, a new British plant, and made some remarks on its affinities and distribution. Mr. W. Carruthers, F.R.S., and the President made some observations by way of comment.—Prof. H. Marshall Ward, F.R.S., read a joint paper by Miss Dale (Pfeiffer student of Girton College) and himself on *Craterostigma pumilum* (Hochst.), a rare plant

which had been brought from Somaliland by Mrs. Lort Phillips. As it had flowered in the Cambridge Botanic Garden during the past summer, and ripe capsules and seeds were obtained, a complete description was possible.—The Rev. T. R. Stebbing, F.R.S., read a paper on "Amphipoda from the Copenhagen Museum and other Sources," in continuation of a former memoir on this subject (*Trans.* Linn. Soc., *Zool.*, vol. vii. part 2). Several new species and a few new genera were described.

Royal Microscopical Society, October 19.—Mr. E. M. Nelson, President, in the chair.—The President referred to a microscope made by Reichert, and exhibited by Messrs. Baker. It was designed for examining opaque objects; a reflector was fitted in the tube of the microscope, which threw the light down upon the object through the objective. This was an old idea revived, but in its present form it was said to be very useful in steel works for examination of fractures of the metal.—Mr. C. Beck exhibited four new students' microscopes, mounted upon true tripod stands.—Messrs. Watson and Sons exhibited another microscope, named the "Fram," specially designed for students' use.—The President exhibited an old microscope by John Cuff, of Fleet Street, date about 1760; and also an old French microscope, date about 1765. He then described some micro-rulings presented to the Society, and made by Mr. H. J. Grayson, of Melbourne; these were mounted in realgar, a medium possessing a refractive index of 2·5, which caused the lines to stand out with great distinctness. Two were micrometers and two were test plates. The micrometer rulings had been critically measured, and were found to be accurately and evenly spaced; and the test plates were beautifully ruled. There was also a specimen of ruling suitable for a diffraction grating. Mr. Grayson had likewise sent a number of slides of test diatoms mounted in realgar, and some mounted in styrax, for comparison. The slides showed no signs of crystallisation; they had stood the heat and rough handling in the post from Melbourne, and the great heat of the past summer; and Mr. Grayson said that, from the method adopted by him, there was no fear of crystallisation taking place.—A paper by Mr. J. Newton Coombe, "The Reproduction of Diatoms," was read by the Secretary, and was illustrated by a series of lantern slides. Mr. Bennett said the paper appeared to throw a new light on the various modes of reproduction, and seemed to point to the removal of the diatoms from the Protophyta to a position among the Conjugatae.—Part iii. of Mr. Millett's "Report on the recent Foraminifera of the Malay Archipelago" was taken as read.

Manchester.

Literary and Philosophical Society, October 18.—J. Cosmo Melvill, President, in the chair.—Mr. J. J. Ashworth exhibited a plant and cobs (both ripened and immature) of Indian corn (*Zea maïs*) grown at Wilmslow, Cheshire. Mr. Charles Bailey made some observations on the exhibits, remarking especially on the inflorescence and fructification of the plant, and on its geographical distribution.—The President communicated a paper by Mr. Peter Cameron, entitled "Hymenoptera Orientalia, or contributions to a knowledge of the Hymenoptera of the Oriental zoological region," Part viii. The author described a large number of new genera and species of hymenopterous insects from the Khasia Hills in the Eastern Himalayas, a district which has not hitherto been worked for its Hymenoptera. The specimens were collected by the natives, some of whom make excellent collectors, but who mostly confine their attention to large or medium-sized species. That the species inhabiting this region must number many thousands, is evident from the fact that in the comparatively small district of Sikkim there are found about 600 species of butterflies and (probably) thousands of moths.

Edinburgh.

Mathematical Society, November 11.—Mr. J. B. Clark, President, in the chair.—Mr. George Duthie communicated a paper on "Systems of circles analogous to Tucker's circles," by Mr. J. A. Third, and Mr. W. L. Thomson read a paper on the "Geometrical theory of the hyperbolic functions."—On the motion of Prof. G. A. Gibson, a committee was appointed to consider the treatment of proportion in elementary mathematics.—The following were elected office-bearers for the current session:—President: Dr. Alex. Morgan. Vice-President: Mr. R. F. Muirhead. Hon. Secretary: Mr. J. W. Butters. Hon. Treasurer: Mr. F. Spence. Editors: Mr. John Dougall, Mr. Charles Tweedie, Dr. C. G. Knott. Committee: Messrs. J. D. H. Dickson, Geo. Duthie, and A. Lindsay.

Paris.

Academy of Sciences, November 14.—M. Wolf in the chair.—Observations of the meteor swarm, by M. Loewy. Owing to the unfavourable weather, on the nights of November 10 and 11 only two meteors belonging to the group of Leonids were observed.—Observations on the sun, made at the Observatory of Lyons with the Brunner equatorial during the second quarter of 1898, by M. J. Guillaume. The results are given in three tables, showing mean area of spots, and their distribution in latitude and longitude respectively.—On the development of uniform functions in Taylor's series, by M. Émile Borel.—On an indeterminate equation, by M. Carl Störmer.—On the production of crystallised tungsten by electrolysis, by M. L. A. Hallopeau. The electrolysis of lithium paratungstate gives metallic tungsten in a well crystallised state. The corresponding sodium and potassium salts yield only tungsto-tungstates on similar treatment.—Volumetric estimation of boric acid, by M. Copaux. The method used is developed from those proposed by Gasselin, R. Thomson, and Barthe, the titration being carried out in presence of alcohol and glycerol, helianthin and phenolphthaleïn being used as indicators. The analyses of borax and ethyl borate quoted are very satisfactory.—New halogen derivatives of guiacol and veratrol, by M. H. Cousin. Trichloro-guiacol, dibromoguiacol, tetrabromoguiacol, trichloroveratrol and tribromoveratrol have been prepared and described.—On a new sugar accompanying sorbite, by MM. Camille Vincent and J. Meunier. When sorbite is crystallised from aqueous solutions, the new sugar remains in the mother liquors. These are then fermented by the sorbose bacterium, which oxidises the residual sorbite, and the sugar is then extracted from the syrup by benzaldehyde in presence of sulphuric acid. The sugar obtained from this is an octite, $C_8H_{18}O_8$, and has not been crystallised. A comparison of its properties with those of sorbite shows that the substances are quite distinct.—Derivatives of natural methylheptenone, by M. Georges Leser. The reaction between sodium, acetic ether, and natural methylheptenone has been studied, and a condensation product $C_{16}H_{26}O$ isolated and analysed.—Volumetric analysis of acetaldehyde, by M. X. Rocques. The results obtained by the method previously given by the author have since been found to vary with the temperature. To obtain exact results it is necessary to carry out the reaction in closed vessels at 50° C.—Estimation of diabetic sugars by the polarimeter, by the reduction coefficient, and by fermentation, by M. Frederic Landolph. The author distinguishes three classes of diabetic sugars, which are clearly indicated by the relations existing between the amount of Fehling's solution reduced, the rotatory power, and the amount of carbon dioxide produced on fermentation.—Some general preliminary conclusions on humic coals, by M. C. Eg. Bertrand.—On the mode of formation of indigo in the methods of commercial extraction, by M. L. Bréaudat. The suggestion that micro-organisms play a part in the indigo fermentation, would appear to have no foundation. The plant especially studied, *Isatis alpina*, contains a hydrolysing diastase and an oxydase. In presence of water, the former splits up indican into indigo-white and indiglucin, and the latter oxidises the indigo-white in presence of an alkali to indigo.—On the absorption of the halogen salts of potassium by plants, by M. E. Demoussy. Plants growing in solutions containing potassium chloride, at first rapidly absorb the salt, but this absorption slows down and finally ceases. Sodium bromide is also absorbed, but not the iodide.—Researches on lesions of the nervous centres produced by experimental hyperthermy, by M. G. Marinesco.—On early lesions of the nervous centres in hydrophobia, by M. V. Babes. Hydrophobia produces cellular and vascular lesions of the grey matter, which can be made out one or two days before the appearance of the first rabic symptoms.—Observations on the general course of histogenesis and organogenesis, by M. J. Kunstler.—On burrowing in the Homaridae and Thalassinidae, by M. Georges Bohn.—On the development of some species of *Trochus*, by M. A. Robert.—Absorption of carbohydrates by roots, by M. Jules Laurent. A maize plant will grow and gain weight in an atmosphere free from carbon dioxide, if supplied with glucose. Sunlight, however, is necessary for this assimilation.—On the

vertebrate layer of the asphalte mines of Pyrimont (Savoy), by M. Ch. Depéret.—On the green ray, by M. L. Libert. Notice of the appearance of this phenomena at Sainte-Adresse.

NEW SOUTH WALES.

Linnean Society, September 28.—Prof. J. T. Wilson, President, in the chair.—On the mountain ash of Southern New South Wales, by Henry Deane and J. H. Maiden.—On two new species of *Eucalyptus* from New South Wales, by R. T. Baker. Two well-defined species, remarkable for the chemical constituents of their oils, belonging to the group Renantherae, and known vernacularly as "Silver Top Stringybark" and "Messmate" respectively, are recorded in this paper. For the first of the two the name *E. laevopinea* is suggested because the oil obtained from the leaves consists largely of pinene which is *laevo-rotatory*, and the name *E. dextropinea* is proposed for the second species owing to the oil consisting largely of pinene, which in this case is *dextro-rotatory*. In both the specific rotation is greater than in the well-known pinenes obtained from the Coniferae, although chemically identical.—A description of certain objects of unknown significance, formerly used by some New South Wales tribes, by Walter R. Harper.—Mr. W. W. Froggatt exhibited a twig from a fruit-tree obtained near Sydney, which had 150 eggs of an undetermined grasshopper attached to it in a double row; also a number of the newly-hatched young insects. These were of interest because of their remarkable resemblance to a common ant (*Iridomyrmex purpureus*, Sm.), which is plentiful in the orchards and bush about Sydney, hunting over the trees for food. It seems probable that this may be a case of protective mimicry, the grasshoppers perhaps being protected against the attacks of insectivorous birds, and the ants also deceived.—Mr. J. Mitchell, of Newcastle, forwarded a brief note announcing his discovery of the print of an insect's wing in the shale overlying the Yard Seam of coal at the base of Flagstaff Hill, Newcastle. There was, he believed, no previous record of the presence of insect remains in rocks of the Permo-Carboniferous Age in New South Wales. He hoped to be able to exhibit the specimen at a future meeting.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 24.

ROYAL SOCIETY, at 4.30—Preliminary Note on the Spectrum of the Corona: Sir J Norman Lockyer, K.C.B., F.R S—On the Condensation Nuclei produced in Gases by the Action of Röntgen Rays, Uranian Rays. Ultra-Violet Light, and other Agents: C. T. R. Wilson.—The Origin of the Gases evolved on Heating Mineral Substances, Meteorites, &c.: Dr, M. W. Travers.—Memoir on the Theory of the Partitions of Numbers: Part 2: Major MacMahon, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rotatory Converters: Prof. S. P. Thompson, F.R.S.

FRIDAY, NOVEMBER 25.

PHYSICAL SOCIETY, at 5.—On the Properties of Liquid Mixtures: R. A. Lehfeldt.—On certain Diffraction Fringes as applied to Micrometric Observations: L. N. G. Filon.

MONDAY, NOVEMBER 28.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Year on Christmas Island: Chas. W. Andrews.

IMPERIAL INSTITUTE, at 8.30.—Gold-Mining in Victoria: Ernest Lidgey.

SOCIETY OF ARTS, at 8.—Acetylene: Prof. Vivian B. Lewes.

INSTITUTE OF ACTUARIES, at 5.30.—Inaugural Address by the President, H. W. Manly.

TUESDAY, NOVEMBER 29.

ZOOLOGICAL SOCIETY, at 8.30.—Further Notes on the Amazonian Lepidosiren: Dr. E. A. Goeldi.—On the Anatomy of Adult and Foetal Specimens of *Pedetes caffer* as compared with that of the *Dipodidae*: F. G. Parsons.—On a New Species of Spiders from Trinidad, West Indies: F. O. Pickard-Cambridge.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Effect of Subsidence due to Coal-Workings upon Bridges and other Structures Stanley Robert Kay.

WEDNESDAY, NOVEMBER 30.

SOCIETY OF ARTS, at 8.—Photographic Developers and Development; C. H. Bothamley, F R.S.

THURSDAY, DECEMBER 1.

LINNEAN SOCIETY, at 8.—On the Biology of *Agaricus velutipes*, Curt.: R H. Biffen.—On the Gastric Glands of the Marsupialia: Jas. Johnstone.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Oxidation of Polyhydric Alcohols in presence of Iron: H. J. H. Fenton and H. Jackson.

FRIDAY, DECEMBER 2.

GEOLOGISTS' ASSOCIATION, at 8.—Contributions to the Geology of the Thame Valley: A. M. Davies.

INSTITUTION OF CIVIL ENGINEERS, at 8—The Sunlight Gold-bearing Reef, Lydenberg, Transvaal: Charles Benjamin Saner.

QUEKETT MICROSCOPICAL CLUB, at 8.

BOOKS, PAMPHLET, SERIALS, &c., RECEIVED.

BOOKS.—Deutscher Botaniker-Kalendar für 1899 (Berlin, Borntraeger).—Symbolae Antillanae seu Fundamenta Florae Indiae Occidentalis: editit I. Urban, Vol. 1, Fasc. i. (Berlin, Borntraeger).—Society for the Promotion of Engineering Education: Proceedings of the Fifth Annual Meeting (Lancaster, Pa.).—Transactions of the American Pediatric Society, Ninth Session (New York).—Psychologische Untersuchungen über das Lesen: B. Erdmann and R Dodge (Halle, Niemeyer).—Animals of To-day, their Life Conversation: C. J. Cornish (Seeley).—Colour in Nature: Dr. M. I. Newbigin (Murray)—Among the Celestials: Captain F. Younghusband (Murray).—The Five Windows of the Soul: E. H. Aitken (Murray).—Australian Legendary Tales: collected by K. L. Parker (Nutt).—More Australian Legendary Tales: collected by K. L. Parker (Nutt).—From Sphinx to Oracle: A S. White (Hurst).—Essai d'une Philosophie Nouvelle: L. Ribert (Paris, Alcan).—Pflanzen-Geographie auf Physiologischer Grundlage: Prof. A. F W. Schimper (Jena, Fischer).—Quick and Easy Methods of Calculating: R. G Blaine (Span)—The Story of Geographical Discovery: J. Jacobs (Newnes).—Text-book of Algebra: Drs. Fisher and Schwatt, Part 1 (Philadelphia, Fisher).—Monographieen Afrikanischer Pflanzen Familien und Gattungen: i. A. Engler; ii. E. Gilg (Leipzig, Engelmann).

PAMPHLET.—Experiments on the Pressures and Explosive Efficiency of Mixtures of Acetylene and Air (Leeds, Jowett).

SERIALS.—Atlantic Monthly, November (Gay).—Proceedings of the Royal Society of Victoria, Vol. xi. Part 1 (Melbourne).—Proceedings of the Indiana Academy of Science, 1897 (Indianapolis).—Journal of the Franklin Institute, November (Philadelphia).

Public School Protractor Scale (Macmillan).

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THURSDAY, DECEMBER 1, 1898.

THE SHIVERING EARTH.

Seismology. By John Milne, F.R.S., F.G.S. Pp. xvi + 320. (London: Kegan Paul, Trench, Trübner, and Co., Ltd.)

PROFESSOR MILNE spent more than twenty years in Japan. When he went there he was experienced as a miner and geologist; and had spent years in Newfoundland, Iceland, Arabia, Siberia and Mongolia as an explorer. He was Professor of mining and geology, and later, of seismology, but for twenty-three years he seems to have devoted himself to the one subject, seismology. The *Transactions* of the Seismological Society of Japan are mainly of his writing. He has published books and numerous papers in England. Through his influence the Japanese Government has established many seismological observatories. He seems to have made a thorough trial of hundreds of seismometers. He enlisted the observational services of many of the foreigners living in Japan. As Secretary of the British Association Committee he has written numerous valuable reports. He has induced all the engineers and architects in Japan to build in accordance with the conclusions drawn by him from his observations. During the last two years he has been the means of establishing twenty-three seismological stations over the world, and he considers it his duty to keep in communication with them all.

In all these years he seems to have missed no chance of supplementing his own mathematical and scientific knowledge by that of anybody whom he could induce to study his subject. He has a pleasant style, and knows from experience as a popular lecturer exactly how his subject may be made interesting to the general reader, and the result is a very readable book which probably contains all that is worth knowing on this subject at the present period of its development. Twenty such volumes might have been written if the author had cared to touch on all the crude speculation of quasi-scientific workers which has from time to time been published.

The earth, about whose interior we know as much as Carlyle's ephemera knew about the lunar theory, is intensely hot under enormous pressure at all depths below a few miles. As the inside cools it contracts, and the crust must also get smaller, and so we have all sorts of crumpling and buckling actions going on slowly always; gradual changes of slope which show themselves mainly by changes of sea level. A small vertical fall or rise in water level may accompany enormously great changes in land area. A lift of all the Tertiary mountainous districts to an average height of 4000 feet would seem to have required only a vertical fall of the water level of twenty-six feet, although the actual breadth of land exposed at coasts may possibly have been very great; and by the possible repeated exposure and submergence of great areas of sedimentary beds, accompanying the probable discontinuous rise of the mountains. Prof. Milne throws an unexpected light on the well-known fact that the great mountain-forming epochs in geological history, epochs of great brady-seismical and volcanic activity, have a close chronological identity with the periods of coal formation. That there has been crumpling in the past is evident enough; but it is interesting to note how we are getting evidence that it is still going on; that the surface of the earth almost everywhere is changing in slope, and falling and rising. Not only have we tilting due to mere change of atmospheric pressure; to rain being better retained by some kinds of crops than others; to the attraction of the moon; to the melting of polar ice; to the erosion of land by sea and river; and the more or less continuous slipping of soil on steep slopes, but to a far more important extent locally, by the deposition of sediment at the mouths of rivers. Every now and again the bending crust undergoes fracture, especially at the bases of monoclines. Some kinds of rock keep fracturing continually; others yield without fracture for long times, and when they fracture they do it with violence; faults are suddenly formed, possibly at great depths, and the motion, the sudden shiver or vibration is transmitted to every part of the earth. If the fault occurs near the surface of the earth, other evidence of it appears than the temporary passage of an imperceptible or terrifying shiver; in minor dislocations, horizontal displacement and sometimes actual contraction. Thus in Japan in the Neo valley in 1891 some plots of ground were diminished 30 per cent. in breadth; river beds were permanently narrowed; forests slipped down from mountain sides to block up valleys and form great lakes; the whole land on one side of the valley lowered in level, and a boundary ridge of high mountains with it. Any one who looks at maps of the world published by the Electric Cable Companies will notice how, along the west side of South America, and at many places elsewhere, a cable is not brought along the coast directly from one place to another; for safety it goes out to sea a great distance. If we did not have actual evidence of it, we could not believe in the numerous sudden large changes of sea bottom which occur, fracturing submarine cables. Except in Japan no people are so enthusiastic in the establishment of Prof. Milne's observatories as those interested in such cables. In 1888 the simultaneous fractures of three submarine cables between Australia and Java by an earthquake caused Australia to mobilise its naval and military forces; and on several occasions Prof. Milne has been able to answer questions of the Colonial Government as to the cause of fracture of cables.

The earthquake or shiver is transmitted to all parts of the earth. The student of acoustics may imagine how the complicated system of vibration gets reflected and refracted and changed in character as it travels, and how different the complete record must be at a place near to the primary disturbance from what it is six thousand miles away, and how anywhere it depends on the local character of the ground. And yet, in spite of this complication, there are interesting general rules which have been derived by the author from observation. A disturbance which has travelled 6000 miles, is recorded by preliminary simple tremors which may have periods of 5 to 12 seconds, the more decided movements having periods of from 20 to 40 seconds. At places nearer, the motion is more complicated; the preliminary tremors have periods of from ·04 to ·2 sec.; the decided movements, say with ranges of motion 10 to 20 mm., have

periods of 2 to $2\frac{1}{2}$ sec.; movements of 1 to 1·5 mm. range, which constitute the greater part of many records, have periods of about 1 sec. The record ends in simple vibrations of periods 1·5 to 4 seconds, like waves of the ocean after a storm.

It is to be presumed that magnetic and other messages are constantly passing to us through the earth, which, if we could only read them—if we knew anything about the cause of terrestrial magnetism, for example—would tell us something about the inside of our habitation. Earth shivers which have travelled from Japan to England seem to be the only messages coming to us through the earth's body which we are able to understand, and which can give us at present any knowledge of what that body is like.

Vibrations from gunpowder explosions in the earth are found to travel faster if the explosions are more violent. Mallet's experiments gave velocities of from 250 to 500 metres per sec. The velocities deduced from the Hell-Gate explosion vary from 1300 metres per second to 6200. More sensitive apparatus records higher velocities, because it has been acted upon by the smaller tremors, and these travel faster than others. Prof. Milne gives a list of earthquake speeds actually observed.

Counting time from the first record anywhere and distance from the place of this first record, measuring either by an arc on the earth's surface, or by a chord, we may look upon the following speeds as not unusual.

Distance from origin.		Apparent velocity in kiloms. per sec.	
In degrees.	In kiloms.	Along arc.	Along chord.
20	2,200	2 to 3	2 to 3
50	5,500	5	5
80	8,800	8	7·5
100	11,100	10	8·8
120	13,200	12 ?	10 ?
160	17,700	16 ?	10·5 ?

The more decided state of motion which arrives with more or less of definiteness of transition after the tremors, travels at a much slower rate (1 to $3\frac{1}{2}$ kiloms. per sec.), and hence the time of duration of the preliminary tremors tells us the distance to the origin. Hence when a seismograph record is made in the Isle of Wight, the distance through which the motion has travelled may generally be estimated with some accuracy, and hence also the violence of the initial disturbance may be guessed at.

It seems to be out of the question that the preliminary tremors have travelled on the earth's surface either as Lord Rayleigh's surface waves or as distortional waves or condensational waves. We can only understand their propagation if we imagine the stuff in the earth at great depths as having cubic elasticity very much greater than that of the best steel, but it is not so easy to understand how such enormous elasticity can be possessed by it. Those students of nature who assume that the behaviour of rock on the earth's surface enables them to speak with easy certainty as to the behaviour of rock at enormous pressure and temperature, must surely find some difficulty in understanding the above observations, just as there are celestial phenomena which must surely disturb the equanimity of the unimaginative persons who apply their farthing rush-light laboratory experience without modification or reserve to all the phenomena of the universe.

The author describes the instruments used now to note or accurately record or measure the motion of the ground or of any point in a structure when an earthquake or shiver passes. The invention of a good instrument for each kind of motion has exhausted much mathematical and inventive genius. It will be found that Prof. Milne is wonderfully fair to other inventors. There seems still to be some doubt as to how much of the motion recorded as horizontal motion of the ground is perhaps something different, an effect of tilting of the instrument. The study of the whole subject has undoubtedly added to our knowledge of vibration phenomena, and I should think that this book will be found of great value by young engineers in charge of electric light stations, where the most important problem of the present time is how to protect citizens from the annoying vibration of reciprocating steam engines. At some future period it may enter the minds of manufacturers of engines that the lineal descendant of Newcomen's slow reciprocating pumping engine is not perhaps the best kind of quick speed motor to use in a thickly inhabited district, and that although passengers by steamer must put up with such a nuisance because there is no forbidding law, the manufacturers of electric energy may easily be compelled to reform their methods of working. The study of all such vibration can be carried on only by the use of instruments such as Prof. Milne describes They have already given useful information in showing how wasteful of coal a badly balanced locomotive may be; in picking out badly constructed parts of the permanent way in railways, in detecting loose parts in bridge construction, and, more important than any of these, they are now giving us information as to the dangerous vibrations of some bridges when trains pass over.

One important result that seems to be gradually establishing itself in the minds of observers is that the number of shakes s per day (vigorous enough for record on a particular kind of instrument) at any place at the time t days after a large earthquake, and at the distance n miles from the epicentre, is a not very complex sort of function of n and t. From the numbers given by Prof. Milne, I venture to say that the law for the after-shocks of the 1891 earthquake is something like

$$s = 117 \div \left(e^{t/31 + n/27} \right),$$

an expression that is worth some study as representing fairly well the result of observation. An enormous amount of labour has been given to the search for a periodicity in earthquakes. It does seem that seismic and barometric maxima coincide, and possibly because of this, or because of snow accumulation, there is greater seismic activity in winter than in summer, although more destructive earthquakes seem to occur in summer. The much looked for dependence of seismic activity on the moon's position is not yet established so well as the

annual and semi-annual periodicities; nor has an effect of the ocean tides yet shown itself. It does not seem to be established that there is any connection between earthquakes and electric or magnetic or auroral phenomena. Slow changes of slope of the earth's surface at any place are continually going on; these are more pronounced in the direction of the dip of certain strata. Those that are mostly of importance in astronomical observatories are due to differences in soils and crops in retaining power for moisture; and Prof. Milne seems to have made a careful study of soils, not merely in regard to their absorption and retention of moisture from the air, but also in regard to their condensation of vapour coming up from beneath, and the results of his observations and experiments seem as if they might be of value to agriculturists.

The author dwells at some length upon curious earth pulsations and earth tremors which seem to be unconnected with earthquakes. They occur everywhere, and their study ought to be of importance to all who have an interest in astronomical or magnetic observatories or in exact measurement of any kind; for example, in careful weighing.

Earth *pulsations* have periodic times of two to three minutes, or even ten or more minutes, beginning and ending for no known reason, lasting for one to three hours. Are they connected with the curious sea-swells of the Pacific which recur annually at very high tide and last for twenty-four hours? Then there are the curious earth *tremors*, not to be confounded with the effects of traffic on roads—they are storms lasting eight to twelve hours, sometimes two to three days, never less than three hours.

No doubt in some cases mere air currents inside the covers of the instruments produce some of the effects observed, but in most cases they are real earth tremors, due possibly to expansions and contractions of the soil by heat and other causes, but this will not explain everything; nor will meteorological changes; nor will winds acting upon the ground in the neighbourhood. The level and slope of ground change perpetually, and the changes seem never to be quite continuous. Prof. Milne cites many observations which show the great importance of the study of these earth tremors in connection with changes of barometric pressure and the escape of fire-damp in mines.

I know that what I have here jotted down after reading this most interesting and valuable scientific work will give only a very poor idea of its contents, and the author will consider that his views are described very crudely. But what can be done in a short notice of such a book? Every sentence in the book contains the result of much thought and observation, and yet it is a book which is just as easy to read as the report of a popular lecture. One has also the feeling that the writer is appealing for sympathy and co-operation of all kinds, without which his great work in the establishment of observatories cannot go on; it is the kind of appeal that one reads between the lines of a traveller's book sometimes, an appeal that the author does not know that he is making. It certainly adds to the interest of an already interesting subject.

JOHN PERRY.

COFFEE AND INDIA-RUBBER IN MEXICO.

Coffee and India-rubber Culture in Mexico. Preceded by Geographical and Statistical Notes on Mexico. By Matias Romero. Pp. xxvi + 417. (New York and London: G. P. Putnam's Sons, The Knickerbocker Press, 1898.)

AT a time when both the products mentioned at the head of the title-page of this book are attracting a great amount of attention as important cultural industries suitable for many of the British Colonies, as well as for other parts of the world, and when india-rubber or caoutchouc especially continues to increase in value and demand, anything bearing on the cultivation of these plants is sure to be eagerly sought after.

It would almost seem that in selecting the title for his book Mr. Romero had in view the probability of catching readers by reversing the order of its correct title, which should more properly stand as "Geographical and Statistical Notes on Mexico: followed by Chapters on Coffee and India-rubber Culture," for in a volume of 417 pages it is not till we arrive at p. 281 that the consideration of the cultivation of coffee is commenced, and it is finished at p. 359. Again, with india-rubber this subject is disposed of in the thirty-three concluding pages of the book. The statistical portion of the book, therefore, occupies its greatest bulk, and is placed first in order. Besides which Mr. Romero candidly says in his introduction that the papers on coffee and rubber were written about a quarter of a century ago, and simply appear now as a translation without any attempt at bringing them up to date; while the geographical and statistical notes were only just published when the introduction was written in January last.

It may be of some interest, as showing how the book has been put together, to quote a few paragraphs from the author's introduction. At p. v. he says, speaking of the article on coffee:

"I published in Mexico three editions of my manual, correcting and adding to each new one, the last one being published in July 1874. There was at the time no interest in coffee culture, and very little attention was therefore paid to my manual. By the advice of a friend, I placed in a book-store about fifty copies on sale, and four or six years later only two or three had been sold."

Again, on p. vi. Mr. Romero gives his reasons for not bringing his matter up to modern times as follows:

"I am very sorry that my present engagements have prevented me from revising this paper up to date; that is, changing such views expressed in the same as my experience has taught me not to be entirely correct, at least, in so far as other regions outside of the southern coast of Chiapas are concerned, as that would require more time than I can afford; and, in my inability to do that work, I prefer to use the paper I wrote long ago exactly in the shape in which it then came out. Since that time all circumstances and conditions of coffee raising have materially changed."

In the introduction to the paper on rubber culture Mr. Romero puts forward the same reasons for not revising his paper, which he says:

"I publish now exactly as it came out over a quarter of a century ago."

Under such circumstances nothing can be said by way of criticism, except to remark that if all Mr. Romero's matter is of the same quality as his description of rubber-yielding trees on p. 378, the book stands in much need of careful revision. J. R. J.

OUR BOOK SHELF.

Practical Mechanics: an Elementary Manual for the Use of Students in Science and Technical Schools and Classes. By Sidney H. Wells, Wh.Sc., A.M.Inst.C.E. Pp. xii + 220. (London: Methuen and Co., 1898.)

THIS book is really a handbook for students who make those quantitative experiments in a mechanical laboratory which are now part of the Applied Mechanics Course of the Science and Art Department. The laboratory system of teaching this subject has passed through all its trials, and has taken its rightful place, not merely in evening science schools, but in the engineering classes of the most pretentious technical institutions in every part of the world. It seems to us that this little book will prove to be a useful guide to teachers. A good teacher will arrange his own methods; he will probably design much of his own apparatus, and he will write out with his own hands the instructions to students using the apparatus, giving up this most important part of his work to no lieutenant, however clever and ingenious. He will, in fact, arrange his apparatus to suit his students and the character of the rest of his teaching. Even he, however, must welcome a description of the apparatus and its uses which have suggested themselves to such an experienced teacher as Mr. Wells.

We have one objection to this book, and it is serious. The apparatus illustrates static laws of force, and force is recognised as a space rate of the doing of work: but we find nowhere any attempt to give to students the fundamental notion of mechanics, that force is a time rate of change of momentum. To supplement what Mr. Wells has given, twenty pieces of well-known apparatus might easily be mentioned which require no special design to fit themselves to quantitative laboratory work, and without a description of such apparatus it seems to us that this book is very incomplete. J. P.

Skiagraphic Atlas: showing the Development of the Bones of the Wrist and Hand. For the use of students and others. By John Poland, F.R.C.S. Pp. 40 and Plates. (London: Smith, Elder, and Co., 1898.)

THIS handy volume is a reprint of a portion of a larger work by its author ("A Practical Treatise on Traumatic Separation of the Epiphyses." London: Smith, Elder, and Co., 1898) which deals with the skiagraphy of the wrist and hand, as revealing *in situ* the stages in ossification of their supporting skeleton. There are nineteen skiagraphs in all, which represent successive phases in the process named at periods between and including the first and seventeenth years, and as a frontispiece there is added a woodcut delineating the isolated hand skeleton at fifteen and a half years, with each bone fully named for comparison with the body of the work. The skiagraphs, with the exception of that of the hand of the author's son, taken by Mr. Swinton, are the work of Mr. C. Webster, and all are excellent and among the best we have seen. A short introductory account is given of the anatomy and growth periods of the several bony centres, with accurate measurements where necessary; and each illustration is accompanied by a brief statement of its salient features. Since, concerning these, some of the author's observations are at variance with what is customarily taught, his book cannot fail to be a useful work of reference both to the anthropotomist and surgical anatomist. The author remarks in his preface that he hopes "in the near future all the bones of the body may be thus portrayed"; and if he should be as successful with the pelvis as he has been with the hand, we would earnestly recommend him and his publishers to lose no opportunity of making the work known to the general public, and of thus forcing home facts which may perchance be brought to bear upon the too prevalent tendency towards premature cycling by young children, which, if not checked by some such salutary means, would seem likely to threaten the rising generation with disaster.

A Manual of Bacteriology, Clinical and Applied. By Richard T. Hewlett, M.D., M.R.C.P., D.P.H., &c., Assistant in the Bacteriological Department, British Institute of Preventive Medicine. Pp. viii + 439. (London: J. and A. Churchill, 1898.)

THIS book should take a very creditable place amongst the smaller manuals of bacteriology which have appeared in recent years. The author has had considerable acquaintance both with the practice and the teaching of his subject, and he has formed just conclusions as to what he should include in his book, and what he should omit. He has included those methods and facts which it is essential for the student to know, with a sufficient amount of the abstract science to enable him to grasp methods and facts intelligently: he has omitted a great mass of scientific detail with which it is needless to burden the student at the outset. The book is thus of moderate compass; it is eminently practical, and its aims are directed to clinical medicine and hygiene in particular. The usual introductory chapters are short, but explicit and accurate. Perhaps the chemistry of bacteria and their products might have been accorded more space, in view of its increasing importance; but the subject of nitrification is well and clearly treated. Methods of cultivation and staining are so plainly put, that the volume becomes a sufficient handbook for laboratory work. The structure and mode of use of oil-immersion lenses is very properly described and illustrated by diagrams. A short chapter on immunity and antitoxins puts this difficult subject as lucidly before the student as the present state of knowledge permits. The principal pathogenic organisms are then described in detail in some 150 pages. The facts are well put, and appear up to date, though the order in which the different bacteria are dealt with is somewhat erratic. Thus *Bacillus aerogenes capsulatus* appears amongst pyogenic and septic organisms; while *B. oedematis maligni*, its close ally, appears nine chapters further on amongst the anaërobes. The enormous importance of streptococci in clinical medicine should, we think, have led to something more than their summary treatment in about four pages. The writer discusses the question of the "pseudo-diphtheria" bacillus at some length, and evidently inclines to the view that it may be only a modified diphtheria bacillus. Under the head of scarlet fever the views of the veterinary profession as to the nature of the so-called "Hendon disease" are adopted in preference to those of the Local Government Board experts, and this without any adequate discussion of the facts: it would have been wiser, in a book of this sort, to omit the question altogether. In the concluding chapters Dr. Hewlett gives a short account of the bacteriology of water, air, and soil, and also of sewage, milk, &c., with a description of the chief methods employed. Antiseptics and disinfectants form the subject of another chapter, and the volume concludes with an account of antitoxins, vaccines, and other bacterial remedies. The illustrations are mostly reproductions of microphotographs, and are fairly good, though not unduly numerous. The book appears to us, on the whole, to be one of the best of the smaller manuals on bacteriology with which we are acquainted, and may be taken by the student as a trustworthy guide for laboratory work.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Asymmetry and Vitalism.

THAT portion of Prof. Karl Pearson's letter in NATURE of Nov. 10 which deals with chemical problems is largely based on misconceptions of the meaning of terms used by chemists. Thus, after quoting a statement of mine regarding optically active compounds, he says: "An optically active compound means merely a preponderance of one kind of enantiomorph." That is precisely what it does *not* mean; that would be an optically active *mixture*. No chemist ever uses the word "compound" when he means "mixture"; I meant one kind of enantiomorph and one only. Moreover, I explained this point in detail in my first reply. Prof. Percy Frankland, as a chemist, has of course found no difficulty in following my meaning; he says that the question which I raised was: "the possibility of producing, without the interference of a living agency, an optically active substance *unaccompanied by its enantiomorph*." A great part of Prof. Pearson's letter is therefore devoted to combating an opinion which I never expressed, and I am consequently relieved from the necessity of further discussing this part, or of calling attention to similar misconceptions which it contains. One point, however, I must notice. Prof. Pearson complains that I have supposed that he meant "twenty" molecules and no more, when in reality he referred to twenty tosses of a coin; and he adds that he was willing to assume the formation of a million molecules. I was led to take his words in the former sense by my impression—as it now appears, a mistaken impression—that he really understood that I was arguing about *single* asymmetric compounds; and I imagined that he purposely assumed the formation of only a small number of molecules in order that they might conceivably be all of one kind of asymmetry.

The part of the letter which I wish especially to consider is that in which Prof. Pearson suggests a hypothetical symmetric mechanism by which he believes a separation of enantiomorphs might be effected. This suggestion, if valid, strikes at the root of a generally accepted principle of molecular asymmetry. I can sincerely say that it is with the utmost diffidence that I venture to call in question any result that Prof. Pearson has arrived at by a mathematical process. But in the present case, I have tried in vain to follow his reasoning; whilst, if I work out the problem in my own way, I arrive at a conclusion exactly the opposite of his. I have no choice, therefore, but to state my results, and to ask Prof. Pearson to correct me if I am wrong.

The tetrahedral representation of two enantiomorphous molecules, each containing a single asymmetric carbon atom, is given in my address (NATURE, vol. lviii. p. 455). The tetrahedra (Figs. 1 and 2) are assumed to be irregular; the four different atoms or groups are situated at different distances from the central carbon atom to which they are attached; the two tetrahedra are enantiomorphous. It must be carefully borne in mind that in these two structures *all corresponding molecular dimensions are identical*; the two structures differ only in their opposite asymmetry.

Prof. Pearson imagines a thin cylindrical sheet of optically inactive mixture to be whirled round the axis of the sheet; and he argues that owing to the position of the centroid in these enantiomorphous tetrahedra, the one kind might be in *stable* equilibrium when, say, their X′ angle sets inwards, and the other, when this sets outwards; "or at least some similar like difference of positions will differentiate like from unlike enantiomorphs." Then, on allowing a strip of the cylindrical surface placed horizontally to fall through a viscous fluid, the difference of resistance caused by this difference of position may effect a separation of the two kinds.

As I have said, I am unable to follow this reasoning. I should discuss the problem as follows:

Let H, X′, Y′, Z′ (Figs. 1 and 2, *loc. cit.*) represent the four different atoms or groups attached to the central carbon atom; and, as regards their masses, let $H < X'$, $X' < Y'$, and $Y' < Z'$.

Then, supposing a thin cylindrical sheet of substance consisting of equal numbers of the two enantiomorphous tetrahedral forms to be whirled about its axis, each tetrahedron, whether right-handed or left-handed, will be in stable equilibrium when the distances of the foregoing groups from the axis of rotation of the sheet are in the order H, X′, Y′, Z′. Therefore the edge Y′ Z′ of either tetrahedron will be nearer to the outer surface of the sheet than the edge H X′; and each of these edges will be inclined towards this outer surface so that the ends Z′ and X′, of these edges, are respectively nearer to it than the ends Y′ and H; and the inclination of corresponding edges will be the same in both tetrahedra. A line joining the centroid of the face H X′ Y′ with Z′, and produced through Z′ to meet the outer surface of the sheet, will form the same angle with this surface, whether the tetrahedron be right-handed or left-handed. Right-handed and left-handed molecules will therefore be affected in exactly the same manner when a strip of the cylindrical surface is placed horizontally and allowed to fall through a viscous fluid; and no separation of the two kinds will occur. The "difference of positions" which Prof. Pearson demands, does not extend beyond the fact that a continuous curve passing towards the surface of the sheet through the groups H, X′, Y′, Z′ in succession, will in the one set of tetrahedra describe a right-handed, in the other a left-handed helix.

I am unable to arrive at any other conclusion than the foregoing.

Prof. Percy Frankland's suggestion of a mechanism by which, starting with a single asymmetric molecule, an optically active compound might be produced unaccompanied by its enantiomorph, practically coincides with that published a little later by Mr. Strong. Such an action is, as I admitted in noticing Mr. Strong's communication, certainly conceivable, although, as an actual process occurring under chance conditions, it is exceedingly improbable. I regret that I overlooked the possibility of such an action.

Prof. Frankland's other suggestion is that, prior to the existence of life on the earth, "the asymmetry of solar radiation may originally have determined the exclusive synthesis of one enantiomorph." I had already considered this possibility. It seems to me that the earth's rotation, to which this asymmetry of solar radiation is due, is so slow as compared with the atomic and molecular motions involved in the production of chemical compounds, that it is difficult to understand how it could perceptibly impress its asymmetry on chemical action.

Although, in view of the arguments adduced by Prof. Percy Frankland and Mr. Strong, I no longer venture to speak of the *inconceivability* of any mechanical explanation of the production of *single optically active compounds asymmetric always in the same sense*, I am as convinced as ever of the *enormous improbability* of any such production under chance conditions. The processes suggested by Prof. Frankland and Mr. Strong are purely hypothetical and are likely to remain so.

The University, Aberdeen, November 17. F. R. JAPP.

Early History of the Great Red Spot on Jupiter.

HAVING collected a number of observations and drawings of objects bearing a suggestive resemblance to this feature, and made during the period from September 5, 1831, to November 14, 1869, I have been enabled to determine the rotation period during that time. This, taken in combination with my discussion of the observations from November 14, 1869, to July 30, 1898 (NATURE, August 4, 1898, and *Monthly Notices* R.A.S., vol. lviii. No. 9), extends the whole interval over which the spot can be pretty certainly identified to nearly 67 years, or 24,435 days, during which the mean rate of rotation was

9h. 55m. 36·2s.

and the total number of rotations

59,071.

My investigation, though quite satisfactory so far as it goes, would be rendered more certain if further observations or drawings could be secured for the period prior to 1869. I should be much obliged, therefore, if any of your readers having such materials in their possession would supply copies, or allow me to have temporary use of the originals. The red spot has varied its appearance so much that it may either appear as a red oval mark, as an elliptic ring, or be practically invisible as at present, though its place may be clearly indicated by a marked hollow in the southern side of the south equatorial belt. Old

drawings of this hollow in the belt will be almost as important, therefore, as delineations of the ellipse itself.

Additional records of this character will serve to exhibit the precise epochs when decided changes occurred in the rate of motion of the spot or its surroundings. The mean rotation period, as mentioned above, seems very well assured from the materials already collected; but it is most desirable to gain more exact information as to the variations, so that the length of the cycle suggested by the observations may be definitely found.

102 City Road, Bristol, November 25. W. F. DENNING.

Galvanometers and Magnetic Dip.

WHILE the variation of magnetic dip in Europe (from about 71° in Aberdeen to 58° in Rome) probably gives little, if any, trouble to users of compasses and portable horizontal galvanometers with pivoted needles, the dip of about 58 *to the south* at the Cape is sufficient to disturb seriously such instruments.

I have seen several galvanometers which were useless until readjusted; these, having been sent out by makers of high reputation, were thought to have received damage on the voyage. I learn that it is a matter of routine in the Post Office to correct all new instruments for dip.

Small pocket compasses are not appreciably affected, because the centre of gravity of the needle is generally well below the point of support, and prismatic compasses escape, probably, on account of the weight of the card.

Instrument makers could easily arrange a small magnetic field in their testing rooms, with a dip to the south of about 60°, in which to adjust instruments intended for the Cape or Australia. A. P. TROTTER.

Cape Town, November 9.

Atropa Belladonna and Birds.

FOR eight years I have had a large plant of Atropa growing here in my garden amongst currants and gooseberries; close by it is a mountain-ash, and at a short distance a large cherry-tree.

Birds, including the blackbird, build in the garden; but although the cherries, currants, gooseberries and raspberries are annually stripped, the Belladonna berries are never touched. The birds are encouraged, and the fruit can be spared.

The Belladonna berries are conspicuous objects from July to November; there are hundreds on my plant every year, long after other fruits have vanished—black, lustrous, luscious-looking—but no bird ever touches them. W. G. S.

Dunstable.

THE ADVANCEMENT OF SCIENCE IN THE ANTARCTIC.

THE President of the Royal Geographical Society has issued an urgent appeal to the Fellows for funds to carry out a National Scientific Expedition to the Antarctic regions on a scale worthy of the traditions of the British nation. He states that a joint committee of the Royal Society and of the Royal Geographical Society has been formed for the purpose of obtaining funds for this purpose, but that "the responsibility of maintaining the credit of the nation in this respect devolves upon the Royal Geographical Society more than on any other body." The Council has accordingly set aside 5000*l*. out of the funds of the Society as a nucleus, to which Mr. Harmsworth, one of the Fellows, has generously added a like sum, and we understand that smaller contributions are rapidly coming in. The cost of a completely equipped expedition will be great, too great we fear for a single Society, even so large and so rapidly growing as the Geographical, to provide, for it is estimated at 100,000*l*. Yet from the point of view of the scientific results sure to be obtained, and the number of the scientific public, the sum is by no means unduly large. Doubtless there will be other Fellows of the Society who can afford and who will not shrink from sharing the position of pre-eminent generosity now occupied by one of their number; but the majority of those interested in the scientific aspects of geography are not wealthy, and they will require assistance from other friends of science. While the vastness of the blank space on the map within the Antarctic circle is sufficient to account for the almost personal feeling of responsibility which Sir Clements Markham and his colleagues acknowledge, there are great gaps in all the natural sciences which only Antarctic research can fill. The physicist, as Prof. Rücker has recently stated, is in the anomalous position of having a theory of terrestrial magnetism far in advance of the facts on which it is based. The meteorologist has two views of atmospheric circulation to consider which can only be reconciled or resolved by observations in the far south. There are geological questions of an interesting kind awaiting solution, including the immensely interesting problem of the former attachment of the southern continents to the land that lies under the south-polar ice-cap. In chemistry uncertainties exist as to the interactions between sea-water and atmospheric gases on the one hand, and marine deposits on the other, which can be studied more fully in the Antarctic than elsewhere. Biology, apart from the certain accumulation of many new species of marine organisms, which might prove a burdensome boon, will find some fascinating problems of environment. The question of the bipolar occurrence of identical species is not as yet overburdened with data for its discussion; but greater interest centres in the life conditions of the vast icy continent—certainly 4,000,000 square miles in area—and absolutely isolated from all the rest of the land of the globe. The climate of most of this land cannot be more rigorous than that of parts of the north polar regions where land-mammals exist; and the biologist, with the exceptional fauna of Australia in view, may reasonably desire to know if there is animal life on Antarctica, and if so what forms it assumes in the unique environment of isolation and low temperature. Even the astronomer may look forward to some return for his contributions to an Antarctic expedition, for where on the land-surface of the globe is there so fine and large a field for the reception and preservation of meteorites? The anthropologist alone can afford, it would appear, to receive the appeal impassively.

All the great scientific societies have long ago expressed their opinion that the time is ripe for a renewal of Antarctic research. The whole newspaper press of the country has applauded the proposal to give effect to this opinion: almost the whole, we ought to say, for a cynically selfish opposition has been offered by one or two of the less influential papers representing the "little Englanders" in science. We hope that all scientific men who have given their approval to the proposed expedition—and who has not?—will ratify that approval, and assist in enabling this country to co-operate with Germany in 1900, and make the last year of the greatest century of scientific advance the world has known the most memorable of all in a field of science whence a great harvest of new facts, but no material return, is to be expected.

Promises and subscriptions are invited to be sent to the credit of the National Antarctic Expedition, to Messrs. Cocks, Biddulph, and Co., Charing Cross, S.W., or to the Royal Geographical Society, 1 Savile Row, W.

THE IMPERIAL UNIVERSITY OF LONDON.

IT is a matter little creditable to English culture that it has required some twenty years of agitation to bring a University for the most important city of the world into the region of practical politics. Within the last fortnight, however, we are glad to know that the machinery of the new Commission has been put in motion, and that inquiries are being made and questions being inquired into of the highest order of importance.

One of these questions has been brought into prominence in a leading article in the *Times* on Saturday last, which shows very clearly that in the opinion of many important persons the University must be launched on no mean scale.

Some of those interested in educational matters suggested some time ago that many of the unused halls of the Imperial Institute could be put to no better service, or one more in harmony with the real intentions of its founders, than their utilisation for some of the purposes of the new University. The Examining Board, hitherto misleadingly called the London University, has always been imperial in its objects, and there is little doubt that when teaching is added to examination the imperial uses will be strengthened.

We shall content ourselves this week in reprinting the *Times* article, which not only indicates very clearly the manner in which Government endowment in the matter of the site may be most economically made, but suggests a somewhat new side of University activity which should not be neglected in these times of commercial competition.

On a future occasion we shall take an opportunity of referring to these and other matters which seem to be among those the consideration of which is necessary to clear the ground for the future labours of the Commission.

The Statutory Commission, appointed under the Act of last Session for the reconstitution of the University of London as a body organised with a strongly developed teaching side, has made a practical beginning with its work during the present week. When that work is accomplished, within the limits imposed by Parliament, it will, no doubt, fail, as every compromise must fail, to realise the ideals of extreme partisans on both sides. Neither those who regarded the old examinational system as perfect and almost sacrosanct, nor those who could see nothing good that did not come out of a teaching institution with a fully-equipped professorial staff, will be altogether satisfied with the change. For ourselves, we cannot doubt that, after unreasonable hesitation and in a somewhat halting and tentative way, a considerable step in advance has been taken for the improvement and expansion of the higher education in the greatest city in the world. But we must not lose sight of the fact that when the Statutory Commission has brought its labours to a close and the results have been laid, in due course, before Parliament, a good deal will remain to be done, partly by legislative action and partly by private effort, before the new system gets a fair start. It is not altogether clear from the Act that the Commissioners have power to decide upon the name of the reconstituted University, though it may be argued as an inference that they can suggest it, and the titles proposed, from time to time, such as the Gresham University and the Albert University, have not met with public acceptance. A point of, perhaps, greater practical importance is that there is no authority to determine where the University is to have its local habitation, and to what extent or in what way teachers "directly appointed by the University," a class expressly mentioned in the schedule to the Act, are to be nominated and provided for. It has been generally assumed that the new University could, for a time at least, be accommodated for the purposes of examination and public meetings in the existing buildings in Burlington Gardens, with the occasional use of rooms lent by some of the chief affiliated colleges. There is reason to believe, however, that this is a misapprehension. We understand that the Government will shortly be under the necessity of resuming the Burlington Gardens site and buildings for the extension of public offices. In that case it would be necessary to furnish the University with new buildings, which at a time when the Treasury will be called upon for an additional grant to the same body for educational objects might not be altogether convenient. The Burlington Gardens property is valued at upwards of 100,000*l.*, but in the hands of the University the rates, taxes, and outgoings are a heavy charge.

There is a magnificent edifice in the best part of London, in which the new University might be housed under conditions worthy of its dignity and aspirations. The stately structure of the Imperial Institute is one of the best examples of modern British architecture. But, though the Institute represents a great conception and has borne excellent fruit, the buildings are far larger than its special work at present requires. It has been suggested that the Imperial Institute, without abandoning any part of its chosen task, might ally itself closely with a kindred institution and, instead of lending its superfluous space for the purposes of casual and miscellaneous exhibitions, might give the enlarged and reformed University a suitable and splendid residence. The privileges and the position of the founders and Fellows and the special interests which the Institute was established to preserve and foster for the advantage of India and the Colonies must, of course, be carefully safeguarded. But the control of the land and buildings by a joint committee, representing the Institute on the one hand and the University on the other, would be full security on this score. It cannot be denied that the Imperial Institute would be an appropriate scene for the ceremonial functions of what might well be called the Imperial University of London. Even at present, the University examines candidates for degrees from the Colonies and India, and, while this duty will be preserved along with the rest of the "external" side of its activity, it will, in all probability, be developed much further when the scheme of which the Statutory Commission is settling the framework has come into full operation. The University, as we have said, is empowered not only to "recognise" competent professors and lecturers in the teaching colleges within the metropolitan area, but also to "appoint" teachers of its own. At the same time it is quite clear that the University is bound not to enter in any way into competition with the colleges recognised as supplying academical teaching for the people of London. To do so would be to depart from the spirit if not the letter of the compromise, on the faith of which the teaching bodies became parties to the scheme of reform. But there is a large sphere of work upon which the existing colleges have not entered and can hardly hope to enter. The establishment of a "Faculty of Commerce"—following the example of Germany—is a development of University work which cannot be neglected in our great centres of trade and industry. In this movement London ought not to be behindhand. Without looking to Government for much more than approval, there are ample resources available, if an appeal is made to the public spirit and liberality of wealthy individuals and of great industrial organisations, for the establishment of professorships of advanced technical study, of applied science in its industrial and commercial aspects, of engineering and electricity, and of many practical branches of economics. These chairs would not compete with the ordinary teaching of the colleges in the abstract and elementary work connected with the sciences in question; but when the student had shown his knowledge of the groundwork he would be able to place himself under the guidance of a selected body of experts and to specialise his studies in preparation for a high degree. The class-rooms and laboratories connected with this part of the work of the University would be for the most part appropriately grouped around the buildings of the Imperial Insitute. There is no reason why degrees given by a Faculty of Commerce and Industry in what might well be called the Imperial University of London should not be eagerly sought for by young men trained in the colleges of Calcutta, Bombay, and Lahore, of Melbourne, Sydney, and Adelaide, of Quebec, Toronto, and Cape Town, as well as by students in the recognised schools of London. At all events, this aspect of the question ought not to be lost sight of either by the Statutory Commission or by the Government.

If, however, the reconstituted University is to take this task in hand, it will be necessary not only to secure the endowment of a number of professorships and lectureships, but to find a fitting place for carrying on the work. The buildings of the Imperial Institute would supply a great part of the acommodation that is needed, but the property includes also some three acres of vacant land which could be turned to account for the erection of laboratories or special class-rooms. It is hardly necessary to mention that the expenditure on the existing buildings has been very large. If the authorities of the Imperial Institute are willing to place the estate at the disposal of the Government, for the purpose of housing the University of London, what seems a very satisfactory arrangement from the point of view of the public might be made. The Prince of Wales and his colleagues are understood to be favourable to such an arrangement, provided, of course, that the special interests with which the Institute is identified are safeguarded.

It may be assumed also that the leading members of the Government look with favour upon the plan, though nothing can be done without the consent of Parliament. The financial details will require to be closely examined. We believe, however, it can be shown that the bargain would be a good one for the State, if the Government were to take over the existing charges on the property of the Imperial Institute, amounting in all to about 5000*l.* a year for rent, taxes, and interest on mortgage. To replace the University of London in a position equal to that in which it stands at present, if it is dispossessed of the Burlington Gardens estate, would probably cost a good deal more, and it would leave no margin, either in space or in money, for the new work which ought to be undertaken if our educational system is to stimulate and nourish our industries and our commerce. It is, in our judgment, most probable that the conspicuous place in the public eye given to the reconstituted University by its installation in the magnificent buildings of the Imperial Institute, especially if it were to be given the designation of the Imperial University of London, would attract substantial support, on a scale not unworthy of the Empire, both in the shape of liberal benefactions and of the enthusiastic and enlightened co-operation of able men. This policy will in no respect interfere with the development of systematic and organised teaching, for which an opportunity will henceforward be afforded, and for the bestowal of degrees founded on such teaching, but will rather complete and strengthen it. At the same time, a higher value and a wider extension will be secured for the external examinations of the University, which opens its doors to competitors from every part of the Empire. It will not be creditable to the British people or to the inhabitants of London, if there is not an energetic attempt to bring what ought to be the centre of the most advanced methods of education up to the level of the work that has been done not only in Berlin and Leipzig, but in many smaller German towns.

NOTES.

The anniversary meeting of the Royal Society took place yesterday as we went to press. An account of the meeting and the annual dinner will be given next week.

M. Depéret has been elected a member of the Paris Academy of Sciences, in the Section of Mineralogy, in succession to the late M. Pomel.

Prof. D'Arcy Thompson, of University College, Dundee, has been appointed to the office of Scientific Member of the Fishery Board for Scotland, vacant by the resignation of Sir John Murray.

Mr. R. T. Baker has been promoted from assistant curator to curator of the Technological Museum, Sydney.

We notice with much regret the announcement of the death of Dr. G. G. Allman, F.R.S., formerly Regius Professor of Natural History in the University of Edinburgh. We regret also to have to announce the death of Mr. Edwin Dunkin, F.R.S., the distinguished astronomer.

The *Southern Cross*, with Mr. Borchgrevink and the other members of the Antarctic expedition under his direction, arrived at Hobart (Tasmania) on Monday. It is expected that the voyage will be continued in a fortnight's time.

It is with great pleasure that we announce the fact that the prize problem of the Naturwissenschaftlich-Mathematischen Facultat of Heidelberg, for a determination of the velocities of various gases and vapours at different temperatures, has been successfully won by Mr. Ernest Stevens, of Brighton, for which he has been awarded the gold medal.

At the last meeting of the Council of the Royal Geographical Society, 112 candidates were elected. This is the largest number elected at any one meeting, and it makes the membership of the Society considerably exceed four thousand.

A violent storm was experienced along the New England coast of the United States on Sunday, and did an immense amount of damage. It is reported that the wind reached a velocity of ninety miles an hour at Block Island.

We learn from the *British Medical Journal* that the monument to Prof. Charcot, which is to stand in front of the Salpêtrière, will be unveiled on Sunday next, December 4, at ten a.m. M. Leygues, Minister of Public Instruction, will preside at the ceremony.

The gypsum boulder, found in the boulder clay of Great Crosby, and described in previous numbers of Nature, has now been finally set up in Islington, Great Crosby. The District Council, advised by Mr. T. Mellard Reade, have had it erected upon a pedestal in the attitude in which it lay embedded in the clay. This was found a difficult thing to do, but the result is most successful, and makes the boulder not only of greater scientific value, but artistically more effective and picturesque.

It is announced in *Science* that the U.S. Board of Ordnance and Fortification has decided to institute an investigation of the possibilities of flying machines for reconnoitreing purposes and as engines of destruction in time of war, and 25,000 dollars of the fund at the disposal of the Board was appropriated for the purpose. The experiments will be carried out under the direction of General A. W. Greely, of the Signal Service, who will have the advantage of the advice of Prof. Langley.

At the meeting of the Society of Public Analysts to be held next Wednesday evening, December 7, an illustrated lecture will be delivered by Mr. A. H. Allen, of Sheffield, on "The use of the micro-spectroscope, and the methods of detecting blood in chemical-legal investigations." Any persons who may be interested in the subject are invited by the Council to attend. Intending visitors, who will not be introduced by members of the Society, are requested to apply for tickets to Mr. E. J. Bevan, Hon. Secretary, 4 New Court, Lincoln's Inn, London, W.C.

The College of Physicians of Philadelphia announces that the next award of the Alvarenga Prize, being the income for one year of the bequest of the late Señor Alvarenga, and amounting to about 180 dollars (36*l.*), will be made on July 14, 1899. Essays presented for competition may be upon any subject in medicine, but must not have been published. They should be received by the Secretary of the College on or before May 1, 1899.

By the death of Prof. Michele Stefano di Rossi, which recently took place at his home at Rocca di Papa, seismologists have lost from their ranks an enthusiastic worker whose name will long be remembered. By his voluminous writings in the *Bolletini del Vulcanismo Italiano*, of which he was editor, and his "Meteorologica Endogena," di Rossi drew the attention of the people of Italy and the world to the importance of studying the ubiquitous movements of the earth's crust; and there is no doubt that it was in great measure the result of this incentive that we now find in the Italian peninsula the elaborate system which exists for seismological investigations. During his later years failing health prevented his taking any active part in the modern developments of seismology; but it was always a pleasure for him to visit the observatory a few steps from his own door, where with Dr. Cancani he could watch and discuss the work of others. The subject to which he devoted the greatest attention was perhaps tromometry, in connection with which he devised many instruments, and made very many thousands of observations. Di Rossi's tremor-recorders are to be seen in nearly all the Italian observatories; whilst the Rossi-Forel scale, as indicating the intensity of an earthquake disturbance, has found acceptance throughout the world.

The *British Medical Journal* states that the arrangements for providing a school of tropical medicine at the branch hospital of the Seamen's Hospital Society, Victoria and Albert Dock, London, E., are making satisfactory progress. A sub-committee, consisting of Mr. Nairne (chairman), Sir C. Gage Brown, K.C.M.G., Mr. Macnamara, Dr. Lauder Brunton, Dr. Stephen Mackenzie, Dr. Manson, Dr. James L. Maxwell, Mr. Johnson Smith, Mr. William Turner, and Mr. James Cantlie, is now engaged in drawing up a constitution for the school, and defining the curriculum. The new buildings will, it is expected, be completed by October 1, 1899, and it is announced that Mr. Chamberlain intends to preside at a festival dinner to be held during the coming parliamentary session.

Referring to Mr. Chamberlain's scheme of establishing a school of tropical medicine, the *Lancet* questions whether the branch hospital at the Royal Albert Dock is the best nucleus for such a school. After pointing out that a very small number of persons suffering from tropical diseases have been under treatment at the branch hospital, the *Lancet* remarks: "It is intended that laboratories should be equipped at the new school for the purposes of research. But surely that is unnecessary. Laboratories already exist with every requisite appliance for such work on the Victoria Embankment, at Chelsea, and at certain metropolitan medical schools. Here qualified medical men already attend from all parts of the world, such as Uganda, West Africa, Australia, Canada, &c., and diseases of tropical climates—such as malaria, leprosy, plague, cholera, Madura foot, &c.—have especially been made the subjects of original research. A knowledge of bacteriology is essential to colonial practitioners, but we doubt whether anything would be gained by the establishment of new laboratories, as is laid down in the scheme for the new school."

We learn from the Trinidad *Bulletin of Miscellaneous Information* that Dr. Morris, superintendent of the Botanical Department for the Lesser Antilles, will have the control of the following stations: Barbadoes, Grenada, St. Vincent, St. Lucia, Dominica, Montserrat, Antigua, and St. Kitts. The Jamaica, Demerara, and Trinidad stations will at present remain independent, and it is proposed to establish a new station at Tobago, which will be under the control of Trinidad.

At the Meteorological Conference at Munich, in 1891, a Committee was formed for the establishment and direction of stations for special cloud observations, and at the meeting of the International Meteorological Committee at Upsala, in 1894, it was decided that regular observations should be made during at least a year, commencing with May 1896. Dr. Hildebrandsson, director of the Upsala Observatory, has just published the observations made there during that period, consisting of nearly three thousand measurements of heights and velocities, of which 1635 have been made by means of photography. The discussion of the results shows that the annual variation of the mean height of the clouds is very pronounced, with a maximum during the months of June and July, and a minimum during winter. During the summer season the mean height of the cirrus is 8176 metres, and of the cumulus 1685 metres. The heights of the upper and middle level clouds are lower than at the Blue Hill Observatory in Massachusetts, while the lower forms are at nearly the same level; this is probably a natural effect of the difference of position of the two stations. The velocity of the upper clouds is greater than that of the lower, and the velocity of all clouds is greater in winter than in summer.

The *Dublin Journal of Medical Science* for October contains an interesting address delivered at the Congress of the Royal Institute of Public Health, by Dr. J. W. Moore, entitled "Ireland, its Capital and Scenery," in which a trustworthy summary of the climate of Dublin is given, based upon a long series of observations made partly by Dr. Moore himself, and partly collected from other sources. He states that the climate of Dublin is, in the fullest sense, an *insular* one, free from extremes of heat and cold, except on very rare occasions. Since January 1865, the extreme readings of the thermometer in a properly protected screen have been $87^{\circ}\cdot2$, in July 1876, and $13^{\circ}\cdot3$, in December 1882—a range of $73^{\circ}\cdot9$. But these values are very exceptional; the average annual range of mean temperature is not quite 20°, viz. January, $41^{\circ}\cdot1$, and July, $60^{\circ}\cdot3$.

Industries and Iron of November 25 is a special motor-car number. Numerous kinds of motor vehicles are described, and the facts brought together show that automobile locomotion has passed through its first stage of experimentation, and is now emerging into a strictly practical stage of definite manufacture. The extension of this kind of traffic last year appears to have been relatively greater than in the previous year. Apparently but little has been done to improve electrical motor vehicles during the past twelve months. In steam vehicles, on the other hand, the advance has been great; England being at the front in this section of self-propelled locomotion. In the construction of vehicles propelled by means of petroleum spirit motors, the advance is quite as noteworthy from a constructional point of view, for British makers are exporting such vehicles to all parts of the world, as well as keeping their factories fully employed in turning out vehicles for home requirements. In regard to engines taking power from explosive admixtures of the vapours of paraffin oils in conjunction with air, there has been little advance. The difficulty which has yet to be overcome is in regard to the fumes of the gases exhausted from the cylinders. Kerosene has, however, proved a most useful servant when used as fuel for steam generators.

We learn from *Science* that Prof. J. K. Rees, of the Columbia University Observatory, has received recently, from Miss Catherine W. Bruce, of New York City, means for building a special photographic telescope. This instrument will be mounted at Helsingfors, and will be employed by Dr. Donner to make polar trail-plates for Dr. Jacoby, in accordance with the plan suggested by him lately at the Astronomical Conference in Boston. Miss Bruce also sent Prof. Rees funds for carrying on the computing work of the observatory. Dr. H. S. Davis, in his work on the re-reduction of Piazzi's star catalogue, has been generously aided by the same liberal giver.

Mr. A. W. Clayden's model of the world, constructed to illustrate the production of ocean currents by constant winds blowing upon the surface of the oceans, is very well known. A large model of this kind, measuring six feet by four, has been made in aluminium by Messrs. Philip and Sons for Mr. Samuel Hordien, of Sydney, who proposes to present it to a museum in that city. An interesting addition to the model is a simple means by which the artificial monsoons can be made to blow separately upon the water, so that the difference of direction of oceanic movements in the monsoon area during the prevalence of these winds can be exhibited.

In the *Journal de Physique* for November, M. André Broca discusses the use of india-rubber supports for isolating physical apparatus from earth-tremors. He points out that when galvanometers, or other apparatus having movable parts, are supported in this way, the disturbances, so far from being reduced, may in some cases be increased tenfold. This is due to synchronisation of the periods of free oscillation of the supported apparatus with the periods of the disturbances, and this synchronisation is only intensified by the rubber supports. On the other hand, when

the apparatus consist entirely of rigid parts, as in optical experiments, there is no better way of ensuring steadiness than by placing the optic bench on a heavy table whose legs rest on four blocks of india-rubber.

DR. H. F. MOORE, of the United States Fish Commission, is reported by *Science* to have been making a careful examination of the physical conditions of Great Salt Lake, with a view to determine its adaptability to oysters and other salt-water and brackish-water animals. While it is known that the salinity of the open lake is so great as to preclude the possibility of the acclimatisation of useful marine animals, it has been suggested that there are certain bays or arms of the lake, in which rivers discharge, where the density is lowered to a point somewhat less than that of ocean water, and where it may be possible for clams, oysters, crabs, terrapins and such animals to survive and multiply. Dr. Moore has not completed his inquiries, but it may be said that the outlook for an augmentation of the aquatic food resources of this region is not very promising, the amount of fresh water entering the lake being subject to great variation, and the existence of a natural food supply for the introduced species being uncertain.

OWING to the thoroughness of the investigations made on the *Challenger* and other deep-sea explorations, our knowledge of the deposits of ocean depths is, if not more extensive, more coherent and better generalised than that of the more complex and changeable deposits in the shallower coastal waters. Great interest therefore attaches to the systematic exploration of the Irish Sea bottom, now being carried on by the Liverpool Marine Biological Committee, of which an instalment appears in the recent number of the *Proceedings* of the Liverpool Geological Society. Messrs. Herdman and Lomas describe and classify forty-four dredged samples, and discuss some of the general questions raised. Among other things the rottenness of many aragonite shells as contrasted with calcite shells, and the general occurrence of organic remains in a drifted condition, rather than *in situ*, are of special geological interest. The authors remark that "a place may be swarming with life and yet leave no trace of anything capable of being preserved in the fossil state, whereas in other places, barren of living things, banks of drifted and dead shells may be formed, and remain as a permanent deposit on the ocean floor."

AN essay on certain eruptive rocks from the Transvaal, and on other South African rocks, forms the inaugural dissertation submitted by Mr. J. A. Leo Henderson to the University of Leipzig, in order to obtain the degree of Doctor of Philosophy. It is published by Dulau and Co, The rocks to which attention is specially directed are the olivine-free Norites, Gabbros and Pyroxenites of the Transvaal; and it is remarked that the Norites of the Zwaartkoppies range (hitherto termed Gabbros) have mutually intergrown or interlocked rhombic and monoclinic pyroxenes. Attention is also drawn to the occurrence of Anorthoclase rocks of the holocrystalline as well as porphyritic facies. These latter are free from quartz, and therefore correspond to the Syenites, being evidently the link between the Syenitic and Granitic rocks on the one hand, and the Diorites and Diabases on the other. For these holocrystalline and porphyritic types of rock respectively, the author suggests the names of "Hatherlite" and "Pilandite," from the localities (Hatherley and Pilandsberge) where they have been met with. Förster's name of "Pantellerite" applies to the volcanic equivalents of these rocks. The essay is illustrated by five plates.

THE old maxim of "If at first you don't succeed, try, try try again," is a very good one to keep in mind when endeavouring even to produce anything good in the photographic line, Success has at last rewarded the efforts of Mr. J. E. Johnson, who has been experimenting since the year 1886 in the manufacture of half-tone cross-line screens for use in the production of process-engravings. Many of us admire the really beautiful reproductions that are of every-day occurrence in our illustrated publications; but how few are there who inquire into the processes by which such illustrations are made possible. If our readers are interested in this kind of work, let them take an illustration by one of these processes, and apply to it a small magnifying glass and examine the texture, so to speak, of the detail. Several excellent illustrations are reproduced in *The Process Photogram* for November, and are accompanied by the first of a series of articles which describe the British half-tone screen: the word "British" is here used because, until quite recently, the whole of the manufacture of these screens was in the hands of Mr. Max Levy, of Philadelphia. The screens which Mr. Johnston has succeeded in making indicate an important departure in British manufacture, and they are capable of doing very fine work. A great amount of money has already been unsuccessfully spent by British, German and French machine-rulers to produce satisfactory half-tone screens, and it is satisfactory to be able to record the fact that a British firm has thoroughly solved the problem. The above-mentioned article, and those that will follow it, give some technical particulars of these new screens, and will be found very interesting. Incidentally we may mention that the *Photogram* for November is full of interesting matter and the usual well-reproduced illustrations.

AN illustrated paper on the ruins of Xkichmook, Yucatan, prepared by Mr. E. H. Thompson, has been published by the Field Columbian Museum, under the auspices of which the archaeological investigations described were carried on. Excavations were made at many points, walls were uncovered and traced, cisterns were cleaned out, graves were examined, and many objects of art were procured. Pottery and flaked stone implements were plentiful, but polished implements and specimens of sculpture were exceedingly rare. Mr. Thompson remarks that at Xkichmook and elsewhere in Yucatan he has never found a single obsidian implement, except slender blades that probably served as knife blades. At Xkichmook he found more plentiful traces of the ancient fabrication of flint implements than in any other group of ruins. With the exception of a celt fragment made of nephrite, not a single polished stone implement was found.

A CATALOGUE of more than two hundred pages, containing particulars and prices of books and papers offered for sale, has just been issued by Messrs. Dulau and Co.

A POPULAR account of Etna and some of its eruptions, illustrated by several reproductions of photographs, and a contour map of the central crater, is contained in a brochure by Prof. Albin Belar, just published at Laibach. The description has been reprinted from the *Laibacher Zeitung*.

DR. R. V. WETTSTEIN has reprinted, from the *Transactions* of the (German) Bohemian Association for Natural Science and Medicine, an interesting paper on the means of protection of the flowers of geophilous plants, *i.e.* those in which the flowering branches are formed beneath the surface of the soil.

THE first of a series of papers on new or imperfectly known species of earthworms collected from various parts of the Japanese empire is contributed to *Annotationes Zoologicae Japonenses* (October 10) by Prof. Seitaro Goto and Mr. Shinkichi Hatai.

MESSRS. SAMPSON LOW, MARSTON, & CO. have published an English edition of the very interesting "New Astronomy," by Prof. David P. Todd, recently reviewed in NATURE

(vol. lviii. p. 173). The volume is profusely illustrated, and contains descriptions of a number of ingenious devices to illustrate astronomical phenomena.

A VOLUME entitled "Notes on Water Supply," containing, among other matters, references, tables, notes, memoranda, and detailed advertisements in relation to water-works engineering, has been prepared by Mr. J. T. Rodda, and is published by Messrs. King, Sell, and Railton, Ltd. The work will be found useful in indicating what water-works appliances are in the market, and their usefulness in modern distribution of water supply.

TWO publications of the U.S. Department of Agriculture (Division of Biological Survey) have reached us:—"Life-zones and Crop-zones of the United States," by C. H. Merriam, the Chief of the Survey; and "the Geographical Distribution of Cereals in North America," by C. S. Plumb. Both are illustrated by a coloured map of the States (including Cuba), showing the delimitation of the "Life-zones"—the Boreal, the Transition, the Upper Austral, the Lower Austral, the Gulf strip of the Lower Austral, and the Tropical zones.

MR. BERNARD QUARITCH announces that the first volume of the work on the zoology of Egypt, with which Dr. John Anderson, F.R.S., has been engaged for some time, is now ready. As the result of five years devoted to collecting, 1500 specimens of reptiles and batrachians were brought together, of which more than 1400 were permanently preserved. The formation of this collection was the first step towards the preparation of the volume on "Reptilia and Batrachia" now published; for these groups were so poorly represented in the museums of this country and of Europe that it would have been impossible to have derived from them any just conception of the extent of these constituents of the Egyptian fauna. Only 100 copies of Dr. Anderson's work have been printed. Purchasers of the first volume, now available, do not bind themselves to take further volumes.

SINCE the discovery by Graham, in 1856, of the remarkable property of palladium of absorbing hydrogen, many researches have been carried out with the object of throwing some light upon the relations existing between the metal and the gas, and with the result that there are nearly as many different views as experimenters. From the theoretical discussion, there would at first sight appear to be no difficulty in distinguishing experimentally between the alloy or solid solution hypothesis and the view that a definite compound, a hydride, is formed. The pressure-concentration curve, in particular, would be expected to decide at once between these two views. But the application of this method is rendered difficult, if not useless, by the fact that the shape of the curve varies greatly with temperature. At 100° C., for instance, the horizontal portion required by the hypothesis of Pd_2H being present is well marked (Troost and Hautefeuille), but at 200° C. no trace of this is present. Of the electrical methods tried, the most recent is that of Dr. J. Shields (*Proc. Roy. Soc. Edin.*, vol. xxii. 169), who examined the electro-motive force of the concentration cell, palladium-hydrogen (weak) / dilute sulphuric acid / palladium-hydrogen (strong), where the concentrations of the hydrogen were weak and strong at the two electrodes. The electro-motive force of the cell was found to be zero, or nearly so. This is opposed to the solid solution hypothesis, and agrees better with the view that a definite chemical compound is formed.

THE additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Mrs. M. Riach; a Guinea Baboon (*Cynocephalus sphinx*, ♂) from Africa, presented by Captain Armitage; a Smith's Dwarf Lemur (*Microcebus smithi*) from Madagascar; a Crab eating Opossum (*Didelphys cancrivorus*) from Tropical America, two One-wattled Cassowaries (*Casuarius uniappendiculatus*) from New Guinea, a Common Rhea (*Rhea americana*) from the Argentine Republic, deposited; a Tesselated Snake (*Tropidonotus tesselatus*) European, purchased; a Yak (*Poephagus grunniens*, ♀), a Llama (*Lama peruana*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN DECEMBER:—

December 2. Venus at maximum diameter 63″·4.
3. Mercury at greatest E. elongation (21° 3′), and visible after sunset.
5. 20h. 2m. to 21h. 11m. Occultation of 55 Leonis (mag. 6) by the moon.
6. 12h. 54m. to 13h. 24m. Occultation of ϵ Leonis (mag. 5·1) by the moon.
10. 8h. 42m. Minimum of Algol (β Persei).
10-12. Meteoric shower from Gemini (Radiant 108° + 33°.)
13. Neptune 52′ N. of ζ Tauri.
13. 5h. 30m. Minimum of Algol (β Persei).
14. 19h. Neptune in opposition to the sun.
15. Mars. Apparent diameter 12″·6. Illuminated portion of disc 0·951.
15. Jupiter. Apparent diameter 30″·2.
19. 3h. 0m. to 3h. 46m. Occultation of κ Piscium (mag. 5) by the moon.
23. 9h. 4m. to 10h. 11m. Occultation of 47 Arietis (mag. 5·9) by the moon.
27. 11h. 38m. Middle of a total eclipse of the moon. The total phase endures from 10h. 57m. to 12h. 27m., a period of about $1\frac{1}{2}$ hours. The magnitude of the eclipse will be = 1·383, the moon's diameter being considered = 1.
29. 10h. 1m. to 11h. 16m. Occultation of ζ Cancri (mag. 5) by the moon.

A NEW COMET.—Two telegrams from Kiel announce observations of a new comet discovered by Chase.

The first from Newhaven, dated November 24, gives the position of this object on November 14, 12h. 38m. Newhaven time, as R.A. 10h. 7m. 4s., and Declination + 22° 55′; the motion being + 1m. 36s. in R.A., and + 4′ in Declination. It was described as "faint."

The second telegram, dated November 25, gives an observation made by Coddington on November 23, at 17h. Lick time. The Right Ascension then was 10h. 21m. 48s., and the Declination + 23° 37′

NOVEMBER METEORS.—The observations of the November meteors have been very much hindered owing to the extremely cloudy weather that has prevailed nearly everywhere. There seems, however, to have been greater success with the Leonids on the night of the 13-14th of last month. M. Janssen (*Comptes rendus*, November 21) eliminated cloudy weather by going up about 200 metres in a balloon at two o'clock on the morning of the 14th. M. Hausky, who was with the party, observed the constellation of Leo, while the others took different portions of the sky. Between 2h. 45m. to 4h. 30m., however, only 25 Leonids were recorded. It is stated that next year ascensions on a large scale will be organised. At the Observatory of Lyons the weather was very favourable, and some useful observations were made by M. André and Guillaume. The former observer, in a watch lasting from 8h. to 12h. 15m., observed 34 meteors, 22 of which he estimated as Leonids. M. Guillaume, from 13h. 4m. to 16h. 5m. saw no less than 134 in three hours, which is about 45 meteors an hour. The radiant point he deduced was 155° + 18°.

PARALLAX OF η PEGASI.—In this column for September 10 last, we gave a brief note concerning the determinations of the velocities in the line of sight of the variable η Pegasi, made by Prof. W. W. Campbell. Concerning the parallax of this star, Mr. C. E. Stromeyer writes to us and suggests that "photographs or micrometric measurements of the position of this star should be taken at periods when its velocity in the line of sight

is a maximum or a minimum; as, for instance, in May 1896, July 1897, August 1898, September 1899, &c. Should it then be found that the angular displacement is less than one-tenth of a second, we have at least sufficient data to be able to say that this star has a parallax of less than one-twentieth of a second. Possibly photographs or micrometric measurements are available in some observatories."

THE NEW PLANET WITT DQ.—The discovery of the little planet Witt DQ is of such importance that it behoves astronomers now to seek out a name for it which will be appropriate. The minor planet family, which now numbers some hundreds, has practically monopolised most of the gods and goddesses, so that a suitable choice in its nomenclature is not an easy matter. Prof. S. C. Chandler, with all due regard to the right of the discoverer, both by courtesy and the precedent of custom, of suggesting a name, proposes Pluto, which he thinks is appropriate in many ways. The other sons of Saturn have all worthily been assigned to major and minor planets; but Pluto has been, up to the present, omitted. Moreover, as Prof. Chandler says, "there is a certain fitness in the appellation arising from its faintness or invisibility on ordinary occasions. Pluto, under his older name, Hades, was the 'invisible' or 'unknown,' the god of darkness. This invisibility, he removes, with the helmet forged for his concealment by Vulcan, when he comes to perihelion opposition, shining then as a comparatively bright star, perhaps visible to the naked eye. This helmet, by the way, could serve as his conventional planetary symbol, if one is desired."

SCIENCE IN EDUCATION.[1]

WHEN the history of education during the nineteenth century comes to be written, one of its most striking features will be presented by the rise and growth of science in the general educational arrangements of every civilised country. At the beginning of the century our schools and colleges were still following, with comparatively little change, the methods and subjects of tuition that had been in use from the time of the Middle Ages. But the extraordinary development of the physical and natural sciences, which has done so much to alter the ordinary conditions of life, has powerfully affected also our system of public instruction. The mediaeval circle of studies has been widely recognised not to supply all the mental training needed in the ampler range of modern requirement. Science has, step by step, gained a footing in the strongholds of the older learning, Not without vehement struggle, however, has she been able to intrench herself there. Even now, although her ultimate victory is assured, the warfare is by no means at an end. The jealousy of the older régime and the strenuous, if sometimes blatant, belligerency of the reformers have not yet been pacified; and, from time to time, within our public schools and universities, there may still be heard the growls of opposition and the shouts of conflict. But these sounds are growing fainter. Even the most conservative don hardly ventures nowadays openly to denounce science and all her works. Grudgingly, it may be, but yet perforce, he has to admit the teaching of modern science to a place among the subjects which the university embraces, and in which it grants degrees. In our public schools a "modern side" has been introduced, and even on the classical side an increasing share of the curriculum is devoted to oral and practical teaching in science. New colleges have been founded in the more important centres of population, for the purpose, more particularly, of enabling the community to obtain a thorough education in modern science.

The mainspring of this remarkable educational revolution has, doubtless, been the earnest conviction that the older learning was no longer adequate in the changed and changing conditions of our time; that vast new fields of knowledge, opened up by the increased study of nature, ought to be included in any scheme of instruction intended to fit men for the struggle of modern life, and that in this newer knowledge much might be found to minister to the highest ends of education. Nevertheless, it must be admitted that utilitarian considerations have not been wholly absent from the minds of the reformers. Science has many and far-reaching practical applications. It has called into existence many new trades and professions, and has greatly modified many of those of older date. In a thousand varied ways it has come into the ordinary affairs of every-day life. Its cultivation has brought innumerable material benefits; its neglect would obviously entail many serious industrial disadvantages, and could not fail to leave us behind in the commercial progress of the nations of the globe.

So much have these considerations pressed upon the attention of the public in recent years that, besides all the other educational machinery to which I have referred, technical schools have been established in many towns for the purpose of teaching the theory as well as the practice of various arts and industries, and making artisans understand the nature of the processes with which their trades are concerned.

That this educational transformation, which has been advancing during the century, has resulted in great benefit to the community at large can hardly be denied. Besides the obvious material gains, there has been a widening of the whole range and method of our teaching; the old subjects are better, because more scientifically taught, and the new subjects enlist the attention and sympathy of large classes of pupils whom the earlier studies only languidly interested. Nevertheless, it is incumbent on those who have advocated and carried out this change to ask themselves whether it has brought with it no drawbacks. They may be sure that no such extensive reform could possibly be accomplished without defects appearing somewhere. And it is well to look these defects in the face and, as far as may be possible, remove them. In considering how I might best discharge the duty with which I have been honoured of addressing the students of Mason College this evening, I have thought that it might not be inappropriate if, as a representative of science, I were to venture to point out some of the drawbacks as well as the advantages of the position which science has attained in our educational system.

At the outset no impartial onlooker can fail to notice that the natural reaction against the dominance of the older learning has tended to induce an undervaluing of the benefits which that learning afforded and can still bestow. In this College, indeed, and in other institutions more specially designed for instruction in science, provision has also been made for the teaching of Latin, Greek, and the more important modern languages and literatures. But in such institutions, these subjects usually hold only a subordinate place. It can hardly be denied that generally throughout the country, even although the literary side of education still maintains its pre-eminence in our public schools and universities, it is losing ground, and that every year it occupies less of the attention of students of science. The range of studies which the science examinations demand is always widening, while the academic period within which these studies must be crowded undergoes no extension. Those students, therefore, who, whether from necessity or choice, have taken their college education in science, naturally experience no little difficulty in finding time for the absolutely essential subjects required for their degrees. Well may they declare that it is hopeless for them to attempt to engage in anything more, and especially in anything that will not tell directly on their places in the final class-lists. With the best will in the world, and with even, sometimes, a bent for literary pursuits, they may believe themselves compelled to devote their whole time and energies to the multifarious exactions of their science curriculum.

Such a result of our latest reformation in education may be unavoidable, but it is surely matter for regret. A training in science and scientific methods, admirable as it is in so many ways, fails to supply those humanising influences which the older learning can so well impart. For the moral stimulus that comes from an association with all that is noblest and best in the literatures of the past, for the culture and taste that spring from prolonged contact with the highest models of literary expression, for the widening of our sympathies and the vivifying of our imagination by the study of history, the teaching of science has no equivalents.

Men who have completed their formal education with little or no help from the older learning may be pardoned should they be apt to despise such help and to believe that they can very well dispense with it in the race of life. My first earnest advice to the science students of this College is, not to entertain this belief and to refuse to act on it. Be assured that, in your future career, whatever it may be, you will find in literature a source of solace and refreshment, of strength and encouragement, such as no department of science can give you. There will come

[1] An address to the students of Mason University College, Birmingham, at the opening of the session, October 4, by Sir Archibald Geikie, D.C.L., F.R.S.

times, even to the most enthusiastic among you, when scientific work, in spite of its absorbing interest, grows to be a weariness. At such times as these you will appreciate the value of the literary culture you may have received at school or college. Cherish the literary tastes you have acquired, and devote yourselves sedulously to the further cultivation of them during such intervals of leisure as you may be able to secure.

Over and above the pleasure which communion with the best books will bring with it, two reasons of a more utilitarian kind may be given to science students why they should seek this communion. Men who have been too exclusively trained in science, or are too much absorbed in its pursuit, are not always the most agreeable members of society. They are apt to be somewhat angular and professional, contributing little that is interesting to general conversation, save when they get a chance of introducing their own science and its doings. Perhaps the greatest bore I ever met was a man of science, whose mind and training were so wholly mathematical and physical that he seemed unable to look at the simplest subject save in its physical relations, about which he would discourse till he had long exhausted the patience of the auditor whom he detained. There is no more efficacious remedy for this tendency to what is popularly known as "shop" than the breadth and culture of mind that spring from wide reading in ancient and modern literature.

The other reason for the advice I offer you is one of which you will hardly, perhaps, appreciate the full force in the present stage of your career. One result of the comparative neglect of the literary side of education by many men of science is conspicuously seen in their literary style. It is true that in our time we have had some eminent scientific workers, who have also been masters of nervous and eloquent English. But it is not less true that the literature of science is burdened with a vast mass of slipshod, ungrammatical and clumsy writing, wherein sometimes even the meaning of the authors is left in doubt. Let me impress upon you the obvious duty of not increasing this unwieldy burden. Study the best masters of style, and when once you have made up your minds what you want to say, try to express it in the simplest, clearest, and most graceful language you can find.

Remember that, while education is the drawing out and cultivation of all the powers of the mind, no system has yet been devised that will by itself develop with equal success every one of these powers. The system under which we have been trained may have done as much for us as it can do. Each of us is thereafter left to supplement its deficiencies by self-culture. And in the ordinary science-instruction of the time one of the most obvious of these inevitable deficiencies is the undue limitation or neglect of the literary side of education.

But in the science-instruction itself there are dangers regarding which we cannot be too watchful. In this College and in all the other well-organised scientific institutions of the country, the principles of science are taught orally and experimentally. Every branch of knowledge is expounded in its bearings on other branches. Its theory is held up as the first great aim of instruction, and its practical applications are made subsequent and subordinate. Divisions of science are taught here which may have few practical applications, but which are necessary for a comprehensive survey of the whole circle of scientific truth. Now, you may possibly have heard, and in the midst of a busy industrial community you are not unlikely to hear, remarks made in criticism of this system or method of tuition. The importance of scientific training will be frankly acknowledged and even insisted upon, but you will sometimes hear this admission coupled with the proviso that the science must be of a practical kind; must, in short, be just such and no other, as will fit young men to turn it to practical use in the manufactures or industries to which they may be summoned. The critics who make this limitation boast that they are practical men, and that in their opinion theory is useless or worse for the main purposes for which they would encourage and support a great scientific school.

Now I am quite sure that those science students who have passed even a single session in Mason College can see for themselves the utter fallacy of such statements and the injury that would be done to the practical usefulness of this institution and to the general progress of the industrial applications of science if such short-sighted views were ever carried into effect. There can be no thorough, adequate, and effective training in science unless it be based on a comprehensive study of facts and principles, altogether apart from any economic uses to which they may be put. Science must be pursued for her own sake, in the first instance, and without reference to any pecuniary benefits she may be able to confer. We never can tell when the most theoretical part of pure science may be capable of being turned to the most important practical uses. Who could have surmised, for instance, that in the early tentative experiments of Volta, Galvani, and others last century lay the germ of the modern world-grasping electric telegraph? Or when Wedgwood, at the beginning of this century, copied paintings by the agency of light upon nitrate of silver, who could have foretold that he was laying the foundations of the marvellous art of photography?

There can be no more pernicious doctrine than that which would measure the commercial value of science by its immediate practical usefulness, and would restrict its place in education to those only of its sub-divisions which may be of service to the industries of the present time. Such a curtailed method of instruction is not education in the true sense of the term. It is only a kind of cramming for a specific purpose, and the knowledge which it imparts, being one-sided and imperfect, is of little value beyond its own limited range. I by no means wish to undervalue the importance of technical instruction. By all means let our artisans know as much as can be taught them regarding the nature and laws of the scientific processes in which they are engaged. But it is not by mere technical instruction that we shall maintain and extend the industrial and commercial greatness of the country. If we are not only to hold our own, but to widen the boundaries of applied science, to perfect our manufactures, and to bring new departments of nature into the service of man, it is by broad, thorough, untrammelled scientific research that our success must be achieved.

When, therefore, you are asked to explain of what practical use are some of the branches of science in which you have been trained, do not lose patience with your questioner, and answer him as you think such a Philistine deserves to be answered. Give him a few illustrations of the thousands of ways in which science, that might have been stigmatised by him as merely abstract and theoretical, has yet been made to minister to the practical needs of humanity. Above all, urge him to attend some of the classes of Mason College, where he will learn, in the most effectual manner, the intimate connection between theory and practice. If he chance to be wealthy, the experiment may possibly open his eyes to the more urgent needs of the institution, and induce him to contribute liberally towards their satisfaction.

Among the advantages and privileges of your life at college there is one, the full significance and value of which you will better appreciate in later years. You have here an opportunity of acquiring a wide general view of the whole range of scientific thought and method. If you proceed to a science degree you are required to lay a broad foundation of acquaintance with the physical and biological sciences. You are thus brought into contact with the subjects of each great department of natural knowledge, and you learn enough regarding them to enable you to understand their scope and to sympathise with the workers who are engaged upon them. But when your academical career is ended, no such chance of wide general training is ever likely to be yours again. You will be dragged into the whirl of life, where you will probably find little time or opportunity to travel much beyond the sphere of employment to which you may have been called. Make the most, therefore, of the advantages which in this respect you meet with here. Try to ensure that your acquaintance with each branch of science embraced in your circle of studies shall be as full and accurate as lies in your power to make it. Even in departments outside the bounds of your own tastes and ultimate requirements, do not neglect the means provided for your gaining some knowledge of them. I urge this duty, not because its diligent discharge will obviously tell in your examinations, but because it will give you that scientific culture which, while enabling you to appreciate and enjoy the successive advances of other sciences than that which you may select for special cultivation, will at the same time increase your general usefulness and aid you in your own researches.

The days of Admirable Crichtons are long since past. So rapid and general is the onward march of science that not only can no man keep pace with it in every direction, but it has become almost hopelessly impossible to remain abreast of the progress in each of the several sub-divisions of even a single

science. We are entering more and more upon the age of specialists. It grows increasingly difficult for the specialists, even in kindred sciences, to remain in touch with each other. When you find yourselves fairly launched into the vortex of life you will look back with infinite satisfaction to the time when you were enabled to lay a broad and solid platform of general acquirement within the walls of this College.

Perhaps the most remarkable defect in the older or literary methods of education was the neglect of the faculty of observation. For the training of the other mental faculties ample provision was made, but for this, one of the most important of the whole, no care was taken. If a boy was naturally observant, he was left to cultivate the use of his eyes as he best might; if he was not observant, nothing was done to improve him in this respect, unless it were, here and there, by the influence of such an intelligent teacher as is described in Mrs. Barbauld's famous story of "Eyes and No Eyes." Even when science began to be introduced into our schools, it was still taught in the old or literary fashion. Lectures and lessons were given by masters who got up their information from books, but had no practical knowledge of the subjects they taught. Class-books were written by men equally destitute of a personal acquaintance with any department of science. The lessons were learnt by rote, and not infrequently afforded opportunities rather for frolic than for instruction. Happily this state of things, though not quite extinct, is rapidly passing away. Practical instruction is everywhere coming into use, while the old-fashioned cut-and-dry lesson-book is giving way to the laboratory, the field-excursion, and the school-museum.

It is mainly through the eyes that we gain our knowledge and appreciation of the world in which we live. But we are not all equally endowed with the gift of intelligent vision. On the contrary, in no respect, perhaps, do we differ more from each other than in our powers of observation. Obviously, a man who has a quick eye to note what passes around him must, in the ordinary affairs of life, stand at a considerable advantage over another man who moves unobservantly on his course. We cannot create an observing faculty any more than we can create a memory, but we may do much to develop both. This is a feature in education of much more practical and national importance than might be supposed. I suspect that it lies closer than might be imagined to the success of our commercial relations abroad. Our prevalent system of instruction has for generations past done nothing to cultivate the habit of observation, and has thus undoubtedly left us at a disadvantage in comparison with nations that have adopted methods of tuition wherein the observing faculty is regularly trained. With our world-wide commerce we have gone on supplying to foreign countries the same manufactured goods for which our fathers found markets in all quarters of the globe. Our traders, however, now find themselves in competition with traders from other nations who have been trained to better use of their powers of observation, and who, taking careful note of the gradually changing tastes and requirements of the races which they visit, have been quick to report these changes and to take means for meeting them. Thus, in our own centres of trade, we find ourselves in danger of being displaced by rivals with sharper eyes and greater powers of adaptation.

It is the special function of science to cultivate this faculty of observation. Here in Mason College, from the very beginning of your scientific studies you have been taught to use your eyes, to watch the phenomena that appear and disappear around you, to note the sequence and relation of these phenomena, and thus, as it were, to enter beneath the surface into the very soul of things. You cannot, however, have failed to remark among your fellow-students great inequalities in their powers of observation, and great differences in the development of these powers under the very same system of instruction. And you may have noticed that, speaking generally, those class-mates who have shown the best observing faculty have taken foremost places among their fellows. It is not a question of mere brain power. A man may possess a colossal intellect, while his faculty of observation may be of the feeblest kind. One of the greatest mathematicians of this century who, full of honours, recently passed away from us, had so little cognisance of his surroundings, that many ludicrous stories are told of his child-like mistakes as to place and time.

The continued development of the faculty of prompt and accurate observation is a task on which you cannot bestow too much attention. Your education here must already have taught you its value. In your future career the use you make of this faculty may determine your success or your failure. But not only have your studies in this College trained your observing powers, they have at the same time greatly widened the range of your mental vision by the variety of objects which you have been compelled to look at and examine. The same methods which have been so full of benefit to you here can be continued by you in after life. And be assured that in maintaining them in active use you will take effective means for securing success in the careers you may choose to follow.

But above and beyond the prospect of any material success there is a higher motive which will doubtless impel you. The education of your observing faculty has been carried on during your introduction to new realms of knowledge. The whole domain of nature has been spread out before you. You have been taught to observe thousands of objects and processes of which, common though they may be, you had previously taken no note. Henceforth, wherever you may go, you cannot wander with ignorant or unobservant eyes. Land and sea and sky, bird and beast and flower now awaken in you a new interest, for you have learned lessons from them that have profoundly impressed you, and you have discovered meanings in them of which you had never dreamed. You have been permitted to pass within the veil of nature, and to perceive some of the inner mechanism of this world.

Thus, your training in science has not only taught you to use your eyes, but to use them intelligently, and in such a way as to see much more in the world around you than is visible to the uninstructed man. This widened perception might be illustrated from any department of natural science. Let me take, by way of example, the relation of the student of science towards the features and charms of landscape. It may be said that no training is needed to comprehend these beauties; that the man in the street, the holiday maker from town, is just as competent as the man of science to appreciate them, and may get quite as much pleasure out of them. We need not stop to discuss the relative amounts of enjoyment which different orders of spectators may derive from scenery; but obviously the student of science has one great advantage in this matter. Not only can he enjoy to the full all the outward charms which appeal to the ordinary eye, but he sees in the features of the landscape new charms and interests which the ordinary untrained eye cannot see. Your accomplished Professor of Geology has taught you the significance of the outer lineaments of the land. While under his guidance you have traced with delight the varied features of the lovely landscapes of the Midlands, your eyes have been trained to mark their connection with each other, and their respective places in the ordered symmetry of the whole scene. You perceive why there is here a height and there a hollow; you note what has given the ridges and vales their dominant forms and directions; you detect the causes that have spread out a meadow in one place and raised up a hill in another.

Above and beyond all questions as to the connection and origin of its several parts, the landscape appeals vividly to your imagination. You know that it has not always worn the aspect which it presents to-day. You have observed in these ridges proofs that the sea once covered their site. You have seen the remains of long extinct shells, fishes, and reptiles that have been disinterred from the mud and silt left behind by the vanished waters. You have found evidence that not once only, but again and again, after vast lapses of time and many successive revolutions, the land has sunk beneath the ocean and has once more emerged. You have been shown traces of underground commotion, and you can point to places where, over central England, volcanoes were once active. You have learnt that the various elements of the landscape have thus been gradually put together during successive ages, and that the slow processes, whereby the characteristic forms of the ground have been carved out, are still in progress under your eye.

While, therefore, you are keenly alive to the present beauty of the scene, it speaks to you, at every turn, of the past. Each feature recalls some incident in the strange primeval history that has been transacted here. The succession of contrasts between what is now and what has been fills you with wonder and delight. You feel as if a new sense had been given to you, and that with its aid your appreciation of scenery has been enlarged and deepened to a marvellous degree.

And so too is it with your relation to all the other departments of nature. The movements of the clouds, the fall of

rain, the flow of brook and river, the changes of the seasons, the succession of calm and storm, do not pass before your eyes now as they once did While they minister to the joy of life, they speak to you of that all-embracing system of process and law that governs the world. The wayside flower is no longer to your eyes merely a thing of beauty. You have found it to be that and far more—an exquisite organism in which the several parts are admirably designed to promote the growth of the plant and to perpetuate the life of the species. Every insect and bird is now to you an embodiment of the mystery of life. The forces of nature, once so dark and so dreaded, are now seen by you to be intelligible, orderly and capable of adaptation to the purposes of man. In the physical and chemical laboratories you have been brought into personal contact with these forces, and have learnt to direct their operations, as you have watched the manifold effects of energy on the infinite varieties of matter.

When you have completed your course of study and leave this College, crowned, I hope, with academic distinction, there will be your future career in life to choose and follow. A small number among you may, perhaps, be so circumstanced as to be able to devote yourselves entirely to original scientific research, selecting such branches of inquiry as may have specially interested you here, and giving up your whole time and energy to investigation. A much larger number will, no doubt, enter professions where a scientific training can be turned to practical account, and you may become engineers, chemists, or medical men. But in the struggle for existence, which every year grows keener amongst us, these professions are more and more crowded, so that a large proportion of your ranks may not succeed in finding places there, and may in the end be pushed into walks in life where there may be little or no opportunity for making much practical use of the knowledge in science which you have gained here. To those who may ultimately be thus situated it will always be of advantage to have had the mental training given in this Institution, and it will probably be your own fault if, even under unfavourable conditions, you do not find, from time to time, chances of turning your scientfic acquirements to account. Your indebtedness to your professors demands that you shall make the effort, and, for the credit of the College, you are bound to do your best.

Among the mental habits which your education in science has helped to foster, there are a few which I would specially commend to your attention as worthy of your most sedulous care all through life.

In the first place, I would put Accuracy. You have learnt in the laboratory how absolutely essential this condition is for scientific investigation. We are all supposed to make the ascertainment of the truth our chief aim, but we do not all take the same trouble to attain it. Accuracy involves labour, and every man is not gifted with an infinite capacity for taking pains. Inexactness of observation is sure sooner or later to be detected, and to be visited on the head of the man who commits it. If his observations are incorrect, the conclusions he has drawn from them may be vitiated. Thus all the toil he has endured in a research may be rendered of no avail, and the reputation he might have gained is not only lost but replaced by discredit. It is quite true that absolute accuracy is often unattainable; you can only approach it. But the greater the exertion you make to reach it, the greater will be the success of your investigations. The effort after accuracy will be transferred from your scientific work to your every-day life and become a habit of mind, advantageous both to yourselves and to society at large.

In the next place, I would set Thoroughness, which is closely akin to accuracy. Again, your training here has shown you how needful it is in scientific research to adopt thorough and exhaustive methods of procedure. The conditions to be taken into account are so numerous and complex, the possible combinations so manifold, before a satisfactory conclusion can be reached. A laborious collection of facts must be made. Each supposed fact must be sifted out and weighed. The evidence must be gone over again and yet again, each link in its chain being scrupulously tested. The deduction to which the evidence may seem to point must be closely and impartially scrutinised, every other conceivable explanation of the facts being frankly and fully considered. Obviously the man whose education has inured him to the cultivation of a mental habit of this kind is admirably equipped for success in any walk in life which he may be called upon to enter. The accuracy and thoroughness which you have learnt to appreciate and practise at College must never be dropped in later years. Carry them with you as watchwords, and make them characteristic of all your undertakings.

In the third place, we may take Breadth. At the outset of your scientific education you were doubtless profoundly impressed by the multiplicity of detail which met your eye in every department of natural knowledge. When you entered upon the study of one of these departments, you felt, perhaps, almost overpowered and bewildered by the vast mass of facts with which you had to make acquaintance. And yet as your training advanced, you gradually came to see that the infinite variety of phenomena could all be marshalled, according to definite laws, into groups and series. You were led to look beyond the details to the great principles that underlie them and bind them into a harmonious and organic whole. With the help of a guiding system of classification, you were able to see the connection between the separate facts, to arrange them according to their mutual relations, and thus to ascend to the great general laws under which the material world has been constructed. With all attainable thoroughness in the mastery of detail, you have been taught to combine a breadth of treatment which enables you to find and keep a leading clue even through the midst of what might seem a tangled web of confusion. There are some men who cannot see the wood for the trees, and who consequently can never attain great success in scientific investigation. Let it be your aim to master fully the details of the tree, and yet to maintain such a breadth of vision as will enable you to embrace the whole forest within your ken. I need not enlarge on the practical value of this mental habit in every-day life, nor point out the excellent manner in which a scientific education tends to develop it.

In the fourth place, I would inculcate the habit of wide Reading in scientific literature. Although the progress of science is now too rapid for any man to keep pace with the advance of all its departments, you should try to hold yourselves in touch with at least the main results arrived at in other branches than your own; while, in that branch itself, it should be your constant aim to watch every onward step that is taken by others, and not to fall behind the van. This task you will find to be no light one. Even were it confined to a survey of the march of science in your own country, it would be arduous enough to engage much of your time. But science belongs to no country, and continues its onward advance all over the globe. If you would keep yourselves informed regarding this progress in other countries, as you are bound to do if you would not willingly be left behind, you will need to follow the scientific literature of those countries. You must be able to read at least French and German. You will find in these languages a vast amount of scientific work relating to your own department, and to this accumulated pile of published material the journals of every month continue to add. In many ways it is a misfortune that the literature of science increases so fast; but we must take the evil with the good. Practice will eventually enable you to form a shrewd judgment as to which authors or papers you may skip without serious danger of losing any valuable fact or useful suggestion.

In the fifth place, let me plead for the virtue of Patience. In a scientific career we encounter two dangers, for the avoidance of which patience is our best support and guide. When life is young and enthusiasm is boundless; when from the details which we may have laboriously gathered together we seem to catch sight of some new fact or principle, some addition of more or less importance to the sum of human knowledge, there may come upon us the eager desire to make our discovery known. We may long to be allowed to add our own little stone to the growing temple of science. We may think of the pride with which we should see our names enrolled among those of the illustrious builders by whom this temple has been slowly reared since the infancy of mankind. So we commit our observations to writing, and send them for publication. Eventually we obtain the deep gratification of appearing in print among well-known authors in science. Far be it from me to condemn this natural desire for publicity. But, as your experience grows, you will probably come to agree with me that if the desire were more frequently and energetically curbed, scientific literature would gain much thereby. There is amongst us far too much hurry in publication. We are so afraid lest our observations or deductions should be forestalled—so anxious not to lose our claim to priority, that we rush before the world, often with a half-finished performance, which must be corrected, supplemented, or cancelled by some later communication. It is this feverish haste which is largely answerable for the mass of jejune, ill-

digested and erroneous matter that cumbers the pages of modern scientific journals. Here it is that you specially need patience. Before you venture to publish anything, take the utmost pains to satisfy yourselves that it is true, that it is new, and that it is worth putting into print. And be assured that this reticence, while it is a kindness to the literature of science, will most certainly bring with it its own reward to yourselves. It will increase your confidence, and make your ultimate contributions more exact in their facts as well as more accurate and convincing in their argument.

The other danger to which I referred as demanding patience is of an opposite kind. As we advance in our career, and the facts of our investigations accumulate around us, there will come times of depression when we seem lost in a labyrinth of detail out of which no path appears to be discoverable. We have, perhaps, groped our way through this maze, following now one clue, now another, that seemed to promise some outlet to the light. But the darkness has only closed around us the deeper, and we feel inclined to abandon the research as one in which success is, for us at least, unattainable. When this blankness of despair shall come upon you, take courage under it, by remembering that a patient study of any department of nature is never labour thrown away. Every accurate observation you have made, every new fact you have established, is a gain to science. You may not for a time see the meaning of these observations, nor the connection of these facts. But their meaning and connection are sure in the end to be made out. You have gone through the labour necessary for the ascertainment of truth, and if you patiently and watchfully bide your time, the discovery of the truth itself may reward your endurance and your toil.

It is by failures as well as by successes that the true ideal of the man of science is reached. The task allotted to him in life is one of the noblest that can be undertaken. It is his to penetrate into the secrets of nature, to push back the circumference of darkness that surrounds us, to disclose ever more and more of the limitless beauty, harmonious order, and imperious law that extend throughout the universe. And while he thus enlarges our knowledge, he shows us also how nature may be made to minister in an ever augmenting multiplicity of ways to the service of humanity. It is to him and his conquests that the material progress of our race is mainly due. If he were content merely to look back over the realms which he has subdued, he might well indulge in jubilant feelings, for his peaceful victories have done more for the enlightenment and progress of mankind than were ever achieved by the triumphs of war. But his eye is turned rather to the future than to the past. In front of him rises the wall of darkness that shrouds from him the still unknown. What he has painfully accomplished seems to him but little in comparison with the infinite possibilities that lie beyond. And so he presses onward, not self-satisfied and exultant, but rather humbled and reverential, yet full of hope and courage for the work of further conquest that lies before him.

Such is the task in which you may be called to share. When you have entered upon it and have learnt something of its trials and responsibilities, as well as of its joys and rewards, you will look back with gratitude to the training you received within the walls of this College. You will feel even more keenly than you do now how much you owe to the patient kindness and educational skill of your teachers and to the healthy stimulus of contact and competition with your class-fellows. Most heartily do I wish you success in your several careers. Following up the paths which have been opened for you here, may it be yours to enlarge still further the circle of light which science has gained, and to wrest from nature new aids for the service of mankind.

THE BRITISH ASSOCIATION.

BRISTOL MEETING.

SECTION K (BOTANY).

OPENING ADDRESS BY PROF. F. O. BOWER, SC.D., F.R.S., PRESIDENT OF THE SECTION.[1]

III.

THE following considerations influence me in forming an opinion as to the real place of apospory and apogamy in the history of the alternating generations :—

I. The Bryophytes show remarkable uniformity of alternation : irregularities are few ; apogamy is not recorded ; apospory appears rarely, as a physiological refuge for the destitute plant. This uniformity goes along with the protected and dependent condition of the sporophyte. All Pteridophytes have their embryos protected while young, and this seems to have been their primitive condition. The true lesson of the Bryophyta, which include the simplest living Archegoniates, seems thus to be that uniformity of alternation goes with a simple structure, and a protected or dependent condition of the sporophyte ; and this we have reason to believe was the condition of the simpler Archegoniate fruits.

II. The distribution of apogamy and apospory among Archegoniates at large is very irregular ; the Leptosporangiate Ferns are the headquarters ; but they are a peculiarly specialised phylum, with free sporophyte, exposed when mature, though protected while young. They are adapted to special conditions and show a greater plasticity of development than any other Pteridophytes. The Ferns are subject to other abnormalities than apospory and apogamy. The root may develop directly into a shoot, or the apex of the leaf into a bud. I think it has been too readily held that the Ferns occupy a special place as a key to the morphological problem. We should bear in mind how really isolated they are ; they are essentially an extreme, even an extravagant type ; they show the largest sporophylls in the whole vegetable kingdom, with the largest numerical output of spores from each. Many are specialised in accordance with extreme conditions of shade and moisture. These considerations should temper our view of them, not only as material for normal comparison, but also as exponents of abnormality.

III. The fact that in cases of induced apogamy in Ferns archegonia are first produced, clearly shows that in these cases the first intention of the plant is towards a normal production of embryos, while apogamy takes its place as a substitutionary growth. It may remain an open question how far direct apogamy will bear a similar interpretation.

IV. The character of the aposporous and apogamous growths is very anomalous ; their position is not definite ; aposporous growths may arise from the sorus and sporangia, or from the most varied points on the margin or surface of the leaf. With regard to apogamy in Ferns, it appears, as the result of a large number of observations, that though there is an average normal of position, still any one part of the sporophyte—stem, leaf, ramentum, root, sporangium, or even tracheid—may arise, independently of others, from the prothallus. Single sporangia, or groups of them, may appear without vegetative organs of the sporophyte ; leaves without other parts ; in one case, I believe, as many as ten roots have been seen without any other members of the sporophyte ! The close similarity of the parts thus irregularly placed to those formed in regular sequence in the normal plant should be a warning of their abnormality. I cannot see in them any suggestion of a primitive state. Dr. Lang tells me that these exceptional developments form only a small proportion of the individuals in any one culture ; still they are there, and those who hold that apogamous developments are a suitable basis for morphological argument must not pick and choose those cases which suit their views, but must take even the most extravagant into careful estimation. My own view is that these anomalous growths are not a safe guide to past history. But looked upon as the result of a recently acquired transition from one generation already established to the other, following nuclear changes, in the one case of reduction after insufficient nutrition, in the other of doubling of the chromosomes following on plethora, apospory and apogamy are at least intelligible. We shall understand how the transition may take place at one point or at many, while the irregularity of the parts produced offers no morphological difficulty ; it is rather what might have been anticipated if the transition were a ready consequence of the conditions we have noted.

Lastly, a word on Dr. Scott's utilitarian argument. He remarks, "a mode of growth which affords a perfectly efficient means of abundant propagation cannot, I think, be dismissed as merely teratological." We must be clear that utility is no certain evidence of antiquity. As refuges for the physiologically destitute, apogamy and apospory may play an important part *now*, and in so far are not to be dismissed as mere freaks of nature. But in my view they would rank, as regards utility pure and simple, with the formation of adventitious buds on the root-system of a Poplar that has been felled ; or with the bulbils which replace the flowers in so many mountain species ; neither

[1] Continued from p. 91.

these, nor, I think, aposporous or apogamous growths, throw any direct light upon the story of descent.

To sum up then, not only do I find that the facts in our possession, including the wildest anomalies, are consistent with an antithetic theory, but a comparison of normal forms seems to me to support the opinion that the sporophyte has appeared as the result of gradual elaboration from the zygote, a fresh phase having been thus gradually intercalated in the course of evolution. This idea first clearly stated by Celakovsky in 1868, was developed by him in subsequent writings. I endeavoured to place it on a footing of adaptation to external conditions, in 1890; and in 1897 we find Strasburger restating the position in terms almost identical with my own, but upon a basis of nuclear detail which had not been dreamed of when the view was first propounded. Dr. Scott has enthusiastically appreciated the double verification of the forecasts of Prof. Pringsheim; I think that the way in which the antithetic theory is found to work in with the nuclear details recently discovered appeals quite as strongly to my mind.

In the course of this discussion I have not been anxious to point out such difficulties as beset the homologous view: all I have attempted here has been to set aside some of the difficulties which have been suggested in opposition to an antithetic view, and to show that the latter theory will adequately cover the facts.

Returning now to our general inquiry on homology, we see that on the antithetic view the two generations are not *homogenetic;* but they may be in a high degree *homoplastic*, and this homoplasy may be impressed upon the two generations, even in the same species, as in some Lycopods. I have never felt the cogency of the fact that the gametophyte of *L. cernuum* is somewhat similar in outline to the young sporophyte. Both generations are exposed to similar circumstances, and may be reasonably expected to have reacted alike. Moreover, the similarity of form of the "leaves" of prothallus and plant is but slight, and is not maintained in allied species. Their arrangement is variable. Between them also lies the essential structural difference, so widespread among Archegoniate plants, that in the sporophyte stomata and intercellular spaces are present, in the gametophyte they are absent. These are just such differences as point to homoplastic development. More commonly, however, the homoplastic development is only seen in distinct organisms, and in this sense we shall rank the leaf of the Moss as the homoplast, but not the homogene, of the leaf of a Lycopod or of a Fern.

THEORY OF THE STROBILUS.

Some years ago I submitted to the Section a theory of the strobilus in Archegoniate plants. Comparisons were drawn between Pteridophytes and Bryophytes, and it was suggested that the origin of the strobilus of the former was "from a body of the nature of a sporogonial head." I specially pointed out at the time that my object was not a mere hunt after homologies, but to obtain some reasonable view of *the methods of advance* in Archegoniate plants. I wish to lay special stress upon this, for some appear to think that by denying an homology which I have not been at pains to maintain, they invalidate this search after the methods of advance. The Bryophytes as we now see them are our best guides in the search after these methods, even though they may not have been in the direct line of descent of Vascular Plants. As regards the comparison of the strobilus with a sporogonial head, I wish to make it clear that a *Moss* sporogonium is not specially indicated. The expression used has been "the origin of the strobilus from a body of the nature of a sporogonial head"—that is simply a part of the sporophyte which bears spores internally as distinct from a lower vegetative region. We see in more than one sequence of Bryophytes how in a sporogonial head, as thus defined, the spore-production becomes restricted in extent, and relegated towards a superficial position by the formation of a central sterile mass. I am ready to join Dr. Scott in his confession of inability to find anything like an intermediate form between the spore-bearing plant of the Pteridophyta and the spore-bearing fruit of the Bryophyta, and to agree that at the best there is nothing more than a remote parallelism not suggestive of affinity; but none the less I think we should continue to search among the Bryophyta for suggestions as to the *methods* of advance, and to have confidence in transferring these ideas across the gulf, for I believe this to be both a reasonable and a promising method of study.

DORSIVENTRALITY.

Interesting questions arise in connection with dorsiventral structure. In the Equisetineae, and almost all Lycopodineae, the strobilus is of the radiate type, therein corresponding to the radial structure of typical sporogonia. While certain Ferns are of the radiate type, others are conspicuously dorsiventral, even from their earliest embryonic state. Dorsiventral structure also appears in the vegetative region, and sometimes, though rarely, in the strobilus of *Selaginella.* Prof. Goebel, in a chapter of his "Organographie," the publication of which may be recognised as the leading event in the morphological studies of the year, discusses the origin of the dorsiventral state in a number of examples, and his results have a most interesting bearing on our theory of the strobilus.

He shows in the case of *Vaccinium Myrtillus* how the first shoot of the seedling is orthotropic and radial; the lateral shoots, formed after the apical growth of this is arrested, are also orthotropic, but the lateral shoots of higher order become plagiotropic with leaves in two lateral rows. He points out the intermediate steps from one condition to the other, and how finally the growing point itself is influenced by the external agency (apparently light), which leads to a change of the leaf-arrangement. This seems to be the case in many other Phanerogamic plants.

A particularly interesting account is also given of similar changes in *Selaginella.* Some eight species are orthotropic, radial, and isophyllous. *S. sanguinolenta* shows a direct response to external conditions, being upright and isophyllous in bright and dry situations, plagiotropic and anisophyllous in damp and shady situations. The bulk of the genus are, however, either plagiotropic and anisophyllous throughout, or some may have an early orthotropic stage. But he concludes that even in "habitually" anisophyllous *Selaginellas* we have to do with an adaptive character, induced probably by light.

We see then good evidence that in certain cases the dorsiventral shoot is a result of adaptation, and the radial probably the primitive. Was this always so? We need not discuss the case of the gametophyte, as the problem there is even more varied and difficult, and does not at the moment engage our attention. But the question whether in the sporophyte the radial was in all cases the primitive type is clearly related to our theory of the strobilus. The sporogonia of Bryophytes are, with few exceptions, orthotropic, and almost uniformly radial; exceptions such as *Diphyscium* and *Buxbaumia* have been shown to have an interesting relation to the incidence of light, and are readily recognised as derivative. The distinctively strobiloid Pteridophytes mostly maintain this radial structure; this may be so both in strobilus and vegetative organs, as in *Equisetum*, *Isoetes*, in most species of *Lycopodium*, and in some *Selaginellas;* or the vegetative region may be dorsiventral, and the strobilus return to the radial type, as in some species of *Lycopodium* and most *Selaginellas;* but in some *Selaginellas* even the strobilus may be dorsiventral.

In the Ferns the case is less obvious; the large size of the leaves, combined often with a dorsiventral structure of the shoot, makes a comparison with a radial strobilus less easy. Goebel has pointed out that in many dorsiventral Ferns the dorsiventrality is already defined in the *punctum vegetationis*, and does not depend upon a subsequent shifting of the parts. But it should be remembered how many Ferns are orthotropic and radial; that almost all the large genera include species with simple unbranched leaves. Further, the series of the Ophioglossaceae, possibly a distinct phylum from the true Ferns, may be held to illustrate a progressive elaboration of the leaf, from smaller leaved forms which are orthotropic and radial, to larger-leaved forms, which are sometimes orthotropic and radial (*Botrychium*), sometimes plagiotropic, and dorsiventral (*Helminthostachys*). It is not, I think, improbable that these, and also the true Ferns, are referable in origin to an orthotropic strobiloid type, with radial structure. This opinion was in substance suggested in 1894 at Oxford; these recent observations of Goebel on the derivative nature of dorsiventral shoots strengthen the position then taken up, while they supply us with fresh examples of homoplastic development.

CONCLUSION.

This discussion was entered on with a view to finding whither phylogeny as a basis of morphology would lead us. However unprepared we may be to pursue it with certainty into detail, or

to apply a terminology to the sequences which we recognise, we must, I think, accept phylogeny as the natural basis for morphology. I do not think that any middle course between this and an artificial system is possible or reasonable. But here we launch ourselves upon a sea of uncertainties on which we must keep our course with care. Following it, we think we espy certain great movements in nature. We may recognise what we believe to be a true evolutionary sequence, but who is to say whether it is a progressive or a retrograde sequence? It may be even one divergent from some middle point. Our best friend may read the sequence in opposite order to ourselves and arrive at a diametrically opposite conclusion. There is no finality to this judging of probabilities, a fact which should be always before the mind, especially in the warmer moments of discussion.

It is interesting to trace the parallel between the progress of classification of plants as a whole, and that of the classification of their parts. In each case the earlier systems were artificial. We may compare the Linnaean system of taxonomy with the Hofmeisterian organography: in both the rigid application of a preconceived method placed incongruous things in juxtaposition, in each case a widening of the basis of the classification has resulted in a redistribution on more natural lines. The present ideal of taxonomy is the same as that of the phylogenetic organography, viz. to group according to descent. The limitations are alike: systematists and morphologists both find their greatest difficulty in the incompleteness of the record, and the frequent isolation of the thing to be classified.

But without following the obvious parallel further, we may now briefly review our position as regards organography, and the following categories are to be recognised, though they graduate almost imperceptibly into one another:—

Homogeny.—(*a*) *Repetition* of the individual part in successive generations, with the same number and position. This is exemplified by the cotyledons, the foot, and first root.

(*b*) *Essential correspondence* of parts varying in number and position, but corresponding in character and development, produced in a regular sequence; *e.g.* most cases of continued embryology.

(*c*) *Transferred position* of parts, similar in origin and structure to those produced in regular sequence; *e.g.* roots, adventitious buds, sori of *Aspidium anomalum*, aposporous and apogamous growths, many monstrosities; these we may believe to result from a transfer of inherited developmental capability.

Homoplasy.—This may be recognised with varying degrees of probability; starting from cases where the question of community of descent is open (as with nearer circles of affinity), and proceeding to those in which distinct evolution is virtually certain. It remains for future investigation to clear up doubtful points. Meanwhile, taking the case of leaves for the purpose of illustration, we may contemplate the following possibilities:—

(*a*) A possible origin of two homoplastic series of leaves in the same plant, and the same generation (*Phylloglossum*).

(*b*) Two homoplastic series in the same plant, but in different generations (*Lycopodium cernuum*).

(*c*) A possible distinct origin of homoplastic leaves in distinct phyla, but in the same generation (sporophyte of Ferns, Lycopods, Equiseta).

(*d*) A distinct origin of homoplastic leaves in distinct phyla, and distinct generations (*e.g.* leaves of Bryophyta and of Pteridophyta).

Now *Homology* has been used in an extended sense as including many, or even all, of these categories. It seems plain to me that this collective use of the term homology carries no distinct evolutionary idea with it; it indicates little more than a vague similarity; the word will have to be either more strictly defined or dropped. The old categories of parts based upon the place and mode of their origin are apt to be split up if the system be checked by views as to descent. Comparison, aided by experiment, supersedes all other methods, and the results which follow raise the question of terminology of parts which have arisen by parallel development.

In parts which are of secondary importance, such as stipules, pinnae, the indusium, hairs, glands, the inconstancy of their occurrence points to independent origin by parallel development in a high degree; in parts of greater importance, such as leaves, a parallel development may also be recognised, though in a less high degree; in the case of sporangia their acceptance as a category *sui generis* dispelled the old view of their various origin from vegetative parts; but we must remember that this does not by any means exclude a parallel development also in them, by enlargement and septation from some simpler spore-producing body, though this is not yet a matter of demonstration. Finally, the sexual organs are probably homogenetic in all Archegoniate plants, but we have no proof that sexuality arose once for all in the lower plants; the probability is rather the contrary. Thus we may contemplate as very general a polyphyletic origin of similar parts by evolution along distinct lines, but resulting, it may be, in forms essentially similar.

There are two extreme courses open to those who wish to convey clearly to others such matters as these; the one is to use a separate term for each category of parts, which can be followed as maintaining its individual or essential identity throughout a recognised line of descent—in fact, to make a polynomic terminology of members run parallel with a polyphyletic development. The other course is to make it clear always in the use of terms applied to parts, that they do not convey any evolutionary meaning, and to use them only in a descriptive sense. Perhaps the former is the ideal method, and it may be a desirable thing, as polyphyletic origins of parts become more established, that the terminology should be brought to reflect at least the more important conclusions arrived at. How this may be done we leave for the future to decide, though I have indicated a first step in the case of the leaves of Mosses and Ferns.

But, for the present, the whole matter is still so tentative that it is well to be content with something which falls short of the ideal, and to maintain the usual terms, such as stem, leaf, root, hair, sporangium, &c., as simply descriptive of parts which correspond as regards general features of origin, position, and nature; but with no reference either, on the one hand, to conformity to any ideal plan, or, on the other, to any community by descent—in fact we shall preserve the original pre-Darwinian sense of these words, which was purely descriptive, and avoid any attempt to read into them any accessory meaning.

A special interest attends those cases of transfer of inherited developmental capability where a part appears with its normal characters, but in a position which is not usual, such as the transfer of the sori of *Aspidium anomalum*; comparable with these transfers on the one hand are those apogamous growths where roots, leaves, ramenta, sporangia may arise independently out of the usual succession. These may be compared, on the other hand, with those interpolations of extra parts, such as the accessory stipules in the stellate Rubiaceae, the extra stamens in Rosaceae, &c. We are unable as yet to say what it is which determines the position and mode of origin of parts; I do not myself think that Sachs's hypothesis of "Stoff and Form," involving ideas of material differences which have not been demonstrated, will advance the question so much as a careful following of the details in the origin of the parts, say in some of these apogamous growths. Here we see the plant body in a sense analysed before us; any one part may be produced separately from any other. An elucidation of how any one of these is initiated and determined should lead to a knowledge of the influences which act also in the normal sequence, and determine the origin of parts in the plant body at large.

I have attempted to touch upon some of those questions in the Morphology of Plants which specially interest us at present, and I dare say in doing so have revealed to you some of the special weaknesses of this branch of the science. The want of finality in this unravelling of history without documents, the ample latitude for difference of opinion, according to the relative weight attached by one or another to the same facts: these are difficulties inherent in the very nature of our study, while to many minds they increase rather than diminish its attractions. Nevertheless the progress of morphology in late decades has plainly been towards a truer appreciation of how divers forms have originated, and so towards a better recognition of affinities. Seeing that this is clearly the main trend, we may take heart as to the advancement of morphological knowledge. We shall not allow ourselves to be deterred by reason of the want of finality or the deficiency of evidence, however strongly we may feel the weight of these difficulties. We shall rather try to make the best of such evidence as we possess, with the full confidence that, however insoluble the problem of descent may really be, inquiry along scientific lines will at least lead us nearer to the goal.

AN AMPERE BALANCE.[1]

THE Report of the Committee on Electrical Standards for 1897 ended with the following paragraph:—"It thus appears to be a matter of urgent importance that a redetermination of the electro-chemical equivalent of silver should be made, and that the general question of the absolute measurement of electric currents should be investigated. . . ." This work we were asked by the Committee to carry out, and a grant of 75*l.* was voted in its aid. We were thus led to examine into the methods which had been employed by Lord Rayleigh, Prof. Mascart and others, for determining the absolute value of a current, as well as to consider some other methods which have not, as far as we know, been hitherto used.

After much consideration we decided to adopt a form of apparatus which, while generally resembling the type employed by some previous experimenters, possessed certain important differences; and, before expending any part of the grant of 75*l.*, to construct, without expense to the British Association, the following preliminary ampere balance.

On a vertical cylinder about 17 inches high and 6·8 inches in diameter we wound two coils, about 5 inches in height, separated by an axial distance of 5 inches. The coils consisted each of a *single* layer of about 170 convolutions of wire, and were wound in opposite directions. From the beam of a balance there was suspended, inside this cylinder, a light bobbin about 4 inches in diameter, on which was wound a coil about 10 inches long consisting of a *single* layer of 360 convolutions, and the whole apparatus was so adjusted that when the beam of the balance was horizontal the inner and outer coils were coaxial, and the top and bottom of the inner suspended coil were respectively in the mean planes of the outer stationary coils.

This arrangement was adopted because with coils consisting of only one layer the geometrical dimensions could be accurately determined, and because the shapes of the coils lent themselves to the use of the convenient formula, readily expressible in elliptic integrals, for the force, F, between a uniform cylindrical current sheet and a coaxial helix, viz.:—

$$F = \gamma\gamma_h(M_1 - M_2)$$

where γ is the current per unit length of the current sheet, γ_h the current in the helix, and M_1 and M_2 the coefficients of mutual induction of the helix and the circular ends of the current sheet.[2]

The value of a particular current of about 0·63 ampere having been determined *absolutely* by means of this apparatus, the rate at which it would deposit silver under specified conditions was ascertained indirectly, by observing its silver value on a Kelvin balance which had been kept screwed down in a fixed position for several years past, and which had been calibrated many times during that period by reference to the silver voltameter.

The result of this preliminary investigation showed that the silver value of the *true* ampere was so nearly equal to the reputed value, viz. 1·118 milligramme per second, as to require the use of an apparatus still more perfectly constructed, and therefore of a much more expensive character, to enable the error, if any, in this value to be ascertained with accuracy.

We, therefore, started on the design of the instrument, of which we now submit the working drawings, and for the future construction of which we would ask for a grant of 300*l.*, including the unexpended grant of 75*l.* voted last year.[3] And we anticipate that this new piece of apparatus may prove worthy of constituting a national ampere balance, the counterpoise weight for which will be determined purely by calculation based on the dimensions of the instrument, the number of convolutions of wire in the three coils, and the value of the acceleration of gravity at the place where the instrument may be permanently set up. In this particular it will differ entirely from the "Board of Trade Ampere Standard Verified, 1894," which has had its counterpoise weight adjusted so that the beam is horizontal when a current passes through the instrument, which will deposit *exactly* 1·118 milligramme of silver per second under specified conditions. In fact, the proposed ampere balance and the existing ampere standard will differ exactly in the same way as do a Lorenz apparatus and the "Board of Trade Ohm Standard Verified, 1894."

We have to express our thanks to Mr. Mather for taking charge of the construction and use of the preliminary apparatus, for checking all the calculations in connection with the determination of the electro-chemical equivalent of silver that was made with it, as well as for superintending the making of the working drawings of the new ampere balance. We have also to thank Messrs. W. H. Derriman and W. N. Wilson, two of the students of the City and Guilds Central Technical College, for their cordial assistance in carrying out the work.

[1] By Prof. W. E. Ayrton, F.R.S., and Prof. J. Viriamu Jones, F.R.S. (Read before Section A of the British Association, Bristol.)

[2] *Proceedings* of the Royal Society, vol. lxiii., "On the Calculation of the Coefficient of Mutual Induction of a Circle and a Coaxial Helix, and of the Electro-magnetic Force between a Helical Current and a Uniform Coaxial Circular Cylindrical Current Sheet." By Prof. J. V. Jones.

[3] This grant of 300*l.* has since been made.

GEOLOGY OF BIRMINGHAM.

ONE of the most important geological memoirs issued of late years is the "Sketch of the Geology of the Birmingham District," by Prof. Lapworth, F.R.S., with contributions by Prof. W. W. Watts and Mr. W. Jerome Harrison: a companion work to that on the "Geology of South Shropshire," by Profs. Lapworth and Watts, issued four years ago. The present work, like the one just mentioned, was prepared with special reference to the areas to be visited by the Geologists' Association during their long summer excursion. It is not merely a lucid summary of the facts already made known; it contains the latest results of the work done by the author and his associates. The "Birmingham district" is admittedly a large one, being the region within a radius of about thirty-five miles from the city. Thus we find references to the Archæan or Pre-Cambrian rocks of Malvern and the Abberley Hills, of the Wrekin and Lickey Hills, of the Caldecote district and Charnwood Forest. It is stated that the Charnwood or "Charnian Rocks" are theoretically paralleled with the Lower Longmyndian and its volcanic equivalents, and the Caldecote rocks, together with the Barnt Green rocks of the Lickey, are grouped with the Upper Longmyndian and Uriconian.

In the Cambrian areas order is established by comparisons of the quartzites of the Wrekin, Hartshill, and the Lickey. The Hartzhill quartzite is shown to be composed of three main divisions, the upper one containing a band of *Hyolithus*-limestone, the fauna of which answers in part to the *Olenellus*-zone of other regions. Hence this upper or "Camp Hill quartzite" of Hartshill is compared with the Comley or Hollybush Sandstone of the Shropshire and Malvern successions. The Stockingford shales, which overlie the Hartshill beds, are divided into three groups which represent the *Paradoxides* or Menevian zone and portions of the Lingula flags. Comparisons are then made between the Warwickshire strata and those in the north-west of Scotland, the place of the argillaceous Stockingford shales being there taken by the Durness Limestone group.

The Silurian strata (Llandovery to Ludlow), and the Carboniferous system are fairly well known, and the leading facts are pointed out. With reference to the Permian rocks it is observed that, as a general rule, they follow conformably upon the Upper Coal Measures of the district. The origin of the Permian breccias is discussed, and the opinion of Mr. W. Wickham King is quoted to the effect that they are largely torrential deposits formed more or less of scree and talus, swept down in flood times from the sides of steep hill-slopes near at hand. The similar views of Mr. Horace T. Brown respecting these strata in the country near Burton-on-Trent might have been mentioned.

A useful account is given of the Triassic strata which occupy so large a portion of the Birmingham district, and this is followed by a brief notice of the Rhætic beds and Lias. The petrology of the Birmingham district is dealt with by Prof. Watts, and the glacial drifts are described by Mr. Harrison. In conclusion there is a summary of the history of geological research among the rocks of the district.

The entire work is full of valuable information and suggestions, the stratigraphical facts being clearly stated and supported by palæontological evidence where that is forthcoming. Hence for a long time to come, this memoir, which is well illustrated with sections and pictorial views, will be the standard work of reference on the area of which it treats; and the Geologists' Association may be heartily congratulated on having received so important an addition to its *Proceedings*. Of this publication it constitutes the whole of part 9 of volume xv., and it is issued to the public at the price of 1*s.* 6*d.*

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—The Junior Scientific Club held their 195th meeting in the Physiological Lecture Room of the Museum on Friday, November 25. Mr. M. Burr (New College) read a paper on "Collecting in South-Eastern Europe," which was illustrated by lantern slides from photographs taken during his recent journey through Herzegovina and Montenegro. Mr. J. M. Wadmore (Trinity) followed with a paper on "Sun-spots and Faculae." The number of new members this term has been forty-seven.

Cambridge.—The following summary of the results of the Cambridge Scholarship Competition is sadly instructive :—

Scholarships and Exhibitions at Cambridge.

The allied Colleges.—Pembroke, Gonville and Caius, Kings, Jesus, Christ's, St. John's, Emmanuel.

			£
Classics	35	scholarships and exhibitions, value	1710
Mathematics ...	19	,, ,, ,, ,,	1110
Modern languages	3	,, ,, ,, ,,	120
History	2	,, ,, ,, ,,	100
Total for literature and mathematics	59	,, ,, ,, ,,	3040
Natural science ...	9	,, ,, ,, ,,	390

Of the scholarships : 50 per cent. are for classics, 32 per cent. mathematics, 4 per cent. modern languages, 3 per cent. history, and 11 per cent. natural science.

Trinity—

			£
Classics	9	scholarships, &c., value	475 (+ 2 senior scholarships)
Mathematics ...	5	,, ,,	280 (+ 1 senior scholarship)
History	1	,, ,,	40
Natural science ...	5	,, ,,	235
Clare—			
Classics	4	,, ,,	160
Mathematics ...	3	,, ,,	180
History	1	,, ,,	30
Natural science ...	2	,, ,,	120
Trinity Hall—			
Classics	1	,, ,,	60
Mathematics ...	2	,, ,,	140

It will be seen that Trinity and Clare have again treated science quite fairly, as they did last year ; but 3040*l.* in literature and mathematics, and only 390*l.* for science, is a very unsatisfactory distribution of prizes, and does not encourage scientific education in our schools and colleges.

Mr. W. H. Preece, C.B., F.R.S., will distribute the prizes to students at the Merchant Venturers' Technical College, Bristol, on December 21.

The new building extension of the Borough Polytechnic Institute, including workshops and gymnasium, will be formally opened on Thursday next, December 8.

Mr F. P. Barnard having found himself unable to accept the headmastership of University College School, London, the Council have offered it to Mr. J. Lewis Paton, assistant master at Rugby School, who has accepted it.

Mr. E. H. Todd, a student at the South-Western Polytechnic Day College for men, has been appointed to an open exhibition in Physics and Chemistry at Christ Church, Oxford, of the value of 80*l.* per annum, tenable for four years.

According to the twenty-fifth quarterly statement of the President of the University of Chicago, there were 1421 students in attendance during the summer quarter, of whom 591 were in the graduate schools. The assets of the University are valued at about 9,000,000 dollars. The income was 706,973 dollars, and the expenditure 678,399 dollars.

The Commission appointed under the University of London Act, 1898, consisting of Lord Davey (chairman), the Bishop of London, Sir William Roberts, Sir Owen Roberts, Prof. Jebb, Prof. Michael Foster, and Mr. E. H. Busk, with Mr. Bailey Saunders as secretary, has commenced its sittings. The office of the Commission is No. 32 Abingdon Street, Westminster, S.W.

A scheme for the establishment of a Gordon Memorial College at Khartum has been put forward by Lord Kitchener. It is proposed that the principal teachers should be British, and that the supervision should be vested in the Governor-General of the Sudan. The teaching, in its early stages, would be devoted to purely elementary subjects, such as reading, writing, geography, and the English language. Later, and after these preliminary stages had been passed, a more advanced course would be instituted, including a training in technical subjects, specially adapted to the requirements of those who inhabit the valley of the Upper Nile. The fund required for the establishment of the college Lord Kitchener estimates at 100,000*l.*, of which 10,000*l.* would be required for the initial outlay, and the remainder invested for the maintenance of the institution. He announces that the Queen has consented to become patron and the Prince of Wales vice-patron, of the movement, and that a general Council of the leading men of this country is in course of formation.

SOCIETIES AND ACADEMIES.

London.

Physical Society, November 25.—Mr. Shelford Bidwell, F.R.S., President, in the chair.—Mr. R. A. Lehfeldt read a paper on the properties of liquid mixtures, being Part iii. of his communications on that subject. It deals with partially miscible liquids. Measurements are given of the vapour-pressure of mixtures of phenol and water. This pair of liquids is completely miscible above 68° C., and incompletely miscible below that temperature. The law of equilibrium between incomplete mixtures and the vapour over them is investigated, especially at "the critical point," *i.e.* at the point where incomplete miscibility passes over into complete miscibility. It is pointed out that normal organic liquids always mix completely. Ethylene dibromide and formic acid mix on boiling, and separate into two layers when cold. The curves representing the cases of complete mixture are comparable in shape with those previously obtained by Mr. Lehfeldt for mixtures of alcohol and toluene, but they show a still flatter maximum ; so much so that 60 per cent. to 70 per cent. of phenol may be added to water without appreciable effect on the vapour-pressure. To verify this point, a differential pressure-gauge was designed ; the construction and method of using are given in the paper. The behaviour of the liquid is apparently the same above and below the critical point. At temperatures not too close to the critical point the vapour-pressure of a saturated mixture is approximately the sum of the partial pressures, calculated for the two saturated solutions according to Raoult's law. Diagrams are drawn showing the characteristic surface for phenol-water mixtures, with the freezing-points of water and of phenol traced out. Phenol melts under water at 1°·5 C., and forms a cryohydrate containing 4·83 per cent. phenol, melting at − 1·0 C. Prof. S. Young (abstract of communication) : The statement of Mr. Lehfeldt that normal organic liquids always mix completely, should be qualified. There are pairs of normal organic liquids which, though miscible in all proportions, approximate closely to partially miscible liquids, *e.g.* benzene (b.p. 80 C.) and normal hexane (b.p. 69° C.). When American petroleum is fractionally distilled, the benzene which is present in small quantity does not come over at about 80°, but mostly at about 65° ; the most probable explanation appears to be that benzene and hexane behave, as regards distillation, like miscible liquids, a view which is confirmed by an investigation of the boiling-points and also of the specific gravities of mixtures of the two hydrocarbons, an account of which has lately been read before the Chemical Society by Messrs. Young and Jackson. The boiling-point curve is similar in general form to that of phenol and water, as shown by Mr. Lehfeldt, though the deviation from the ordinary form is not so marked. Ten per cent. of benzene has practically no influence on the boiling-point of normal hexane, but 10 per cent. of hexane lowers the boiling-point of benzene nearly 3 C. Also there is always expansion on mixing benzene and hexane, the maximum reaching about 0·4 per cent. Dr. S. P. Thompson asked whether any relation

had been observed between the vapour-pressure and the surface tension of the mixtures. Mr. Lehfeldt was not sure whether the surface-tensions of the components pass into one another at the critical point of mixture.—Mr. L. N. G. Filon then gave an account of his paper on certain diffraction fringes as applied to micrometric observations; it is to a great extent a critical investigation of a paper by A. A. Michelson on the same subject (*Phil. Mag.*, vol. xxx. pp. 1–21, July 1890). Michelson there describes a method for measuring the angular distance between the components of a double star, or the angular dimensions of very small celestial bodies, by means of interference-fringes, using two adjustable slits in front of the objective of a telescope. If the star is double, or if it has an appreciable disc, then by widening the distance between the slits, the fringes become fainter, and in some cases almost vanish. But, by still further widening the slit, the fringes reappear, disappear, and so on. In the paper (*l.c.*) Michelson develops the law of these appearances and disappearances, and gives an expression for the ratio of the angular distance between the components of the double star, or the angular radius of the single source, to the distance between the slits, *on the assumption that the slits are infinitely long and infinitely thin.* Mr. Filon considers that this assumption is unjustified by the conditions of measurement; he reviews the original investigation, and modifies the results. He then proceeds to find equations to represent the intensity of light in the focal plane, for a point source, and for a two-point source. These fringes are only visible over a certain rectangle, called "the rectangle of illumination" of the source. In the case of a two-point source, if the distance perpendicular to the slits, between the geometrical images of the two points, is an integer-multiple of the distance between two fringes, the maxima of one system correspond with the maxima of the other, the fringes overlap and their intensity is augmented. If, however, this distance should be an odd multiple of the half-distance between the fringes, the maxima of one system correspond to the minima of the other, and if *the fringes that are superposed* are of similar intensity, the fringing is nearly obliterated, a result that agrees with Michelson's law. But it is now shown that for this phenomenon to occur (1) the rectangles of illumination of the two sources must overlap to a very large extent, this consideration was neglected by Michelson, and (2) the angular distance between the two stars measured parallel and perpendicularly to the slits, must be less than a definite amount, depending upon the wave-length, and the length and breadth of the slits. In astronomical cases, the second condition is generally satisfied. If the rectangles of illumination do not overlap they can be respectively distinguished, and thus the star can be resolved by direct observation. If, however, an accurate measurement of the distance between the components is required, by Michelson's method, the rectangles must be made to overlap. The paper includes an investigation of a refractometer that Michelson (*l.c.*) proposed to use for increasing the effective aperture of a telescope; it is shown that Michelson's law is generally true for that instrument, but certain limitations are pointed out. Extended sources are next considered, and also the shape and size of the object. The paper concludes with the description of a method, by means of which the ellipticity of a very small disc may be measured by these diffraction fringes in the special case where Michelson's law holds good. In reply to a question from Prof. S. P. Thompson, Mr. Filon said that the minimum breadth of slit with which he had found it practicable to work, using monochromatic light with his telescope, was about half a millimetre.—The President proposed votes of thanks, and the meeting adjourned until December 9.

Chemical Society, November 17.—Prof. Dewar, President, in the chair.—The following papers were read:—Determination of the constitution of fatty acids, Part i., by A. W. Crossley and H. R. Le Sueur. The authors have devised a general method for determining the constitution of a fatty acid of the type $CH_2X.CH_2.COOH$; the method has been proved upon valeric, isovaleric and isobutylacetic acid.—The crystalline form of iodoform, by W. J. Pope. Iodoform is deposited from acetone solution in magnificent hexagonal crystals, of which measurements are given.—The characterisation of racemic compounds, by F. S. Kipping and W. J. Pope. Ladenburg states that if a mixture of an externally compensated substance with one of its active components, deposits on fractional crystallisation fractions of different specific rotations, the compensated substance is racemic; if it is not racemic, the various fractions have the same specific rotation. The authors show that this rule does not hold.—The occurrence of orthohydroxyacetophenone in *Chione glabra*, by W. R. Dunstan and T. A. Henry. The wood of *Chione glabra* has a strong somewhat foecal odour owing to its containing orthohydroxyacetophenone.—Preparation of hyponitrite from nitrite through oxyamidosulphonate, by E. Divers and T. Haga. Sodium carbonate and sulphur dioxide convert sodium nitrite into oximidosulphonate, which on hydrolysis yields sodium oxyamidosulphonate; the latter is decomposed into hyponitrite and sulphite by potash. These facts lead to a good method of preparing hyponitrites.—Absorption of nitric oxide in gas analysis, by E. Divers. A concentrated alkaline solution of sodium or potassium sulphite rapidly absorbs nitric oxide, and may be used for this purpose in gas analysis.—Interaction of nitric oxide with silver nitrate, by E. Divers. Silver nitrate decomposes in a current of nitric oxide at lower temperatures than in air or carbon dioxide; the products are the same in the two cases, namely, silver, silver nitrite and nitrogen peroxide.—Preparation of pure alkali nitrites, by E. Divers. Nitrous gases containing excess of nitric oxide convert potassium or sodium hydroxide or carbonate into nitrite in absence of air; no nitrate is formed.—The reduction of an alkali nitrite by an alkali metal, by E. Divers.—Hyponitrites: their preparation by sodium or potassium, by E. Divers.—Paranitro-orthanisidine, by R. Meldola. A number of derivatives of *p*-nitro-*o*-anisidine are described.

Mathematical Society, November 10.—Prof. Elliott, F.R.S., President, in the chair.—The President feelingly alluded to the losses to the Society occasioned by the recent deaths of Mr. Walter Wren and Dr. J. Hopkinson, F.R.S.—The Treasurer read his report, which was a favourable one. Its reception was moved by Mr. A. B. Kempe, F.R.S., seconded by Mr. S. Roberts, F.R.S., and carried unanimously. The ballot was then taken, with the result that Lord Kelvin, G.C.V.O., was elected President, and Messrs. Elliott, F.R.S., H. Lamb, F.R.S., and Lieut.-Colonel Cunningham, R.E., Vice-Presidents. The other members of Council of the last session remain in office, with the exceptions noted on p. 602 (NATURE, vol. lviii.). The retiring President having vacated the chair, his place was taken by Lieut.-Colonel Cunningham, who called upon Prof. Elliott to read his address, entitled "Some Secondary Needs and Opportunities of English Mathematicians," of which the following is a brief abstract. The address congratulated the Society on the work it had done during the last two years, and in particular on the printing in its *Proceedings* of Sylvester's "Outlines of Seven Lectures on the Partitions of Numbers." It referred to some of the losses by death which had occurred during the two years among mathematicians and members of the Society. It expressed gratification at the holding at Zürich in 1897 of an international Congress of mathematicians, and at other signs of growing co-operation among mathematicians of different nationalities. This co-operation, which the history of the Society had proved to be so valuable at home, should in every way be encouraged on the widest possible scale. Reference was made to some advantages which had accrued from co-operation and mutual encouragement in the history of the Society, and it was in particular enforced that much stimulation had once been exercised by the actual meetings of the Society, in ways for which opportunity still presented itself. The influence which the Society had exercised in widening the scope of British enterprise in pure mathematics was dwelt upon at some length, and illustrated by reference to a former need for advanced and comprehensive treatises on modern subjects, which had been inspiringly exposed by one of the Society's earlier Presidents, Prof. Henry Smith, and since his time largely satisfied. Secondary work was necessary that the transition from narrow to widened views of mathematical opportunity be effected surely and without discouragement. The passion among us for examination into elegant incidentals, which shows itself in the fascination exercised by problem making and solving, must be reckoned with and, in the speaker's opinion, not discouraged. The effort must be to increase the range of interest among students without weakening the facility of acquiring that interest. Unambitious work of definitely educational intention, in subjects now made known to the select few by ambitious treatises, is needed. Instructors are required where leaders have been found. The logical improvement of elementary teaching is proceeding. Unassuming, partial and introductory books of didactic character on modern subjects are wanted. Opportunities for didactic work, and for the utilisation of our love of

detail, were illustrated by reference to subjects connected with the Theory of Functions, and with Lie's Theory of Continuous Groups. Greater attention to historical and bibliographical work, in order to disseminate interest in mathematical advancement, was also advocated. It was noticed with satisfaction that a great stimulus to the production of specialist literature of this kind in our own tongue had been given by the American Mathematical Society. In conclusion, thankful acknowledgment was made of the great debt owed by the Society to Mr. Jenkins and Mr. Tucker, who from the days of its infancy had been its honorary secretaries, and of whom the former found it necessary three years ago to claim rest from his arduous duties, and now has had further to ask to be relieved from service on the Council.—On the motion of the chairman, ratified by the members present, Prof. Elliott consented to the publication of the address in the *Proceedings*.—The following papers were formally communicated :—The structure of certain linear groups with quadratic invariants, Dr. L. E. Dickson ; multiform solutions of certain differential equations of physical mathematics and their applications, Mr. H. S. Carslaw ; on the null spaces of a one system and its associated complexes, Mr. W. H. Young ; and on the functions Y and Z which satisfy the identity $4(x^p - 1)/(x - 1) = Y^2 \pm pZ^2$, Prof. L. J. Rogers.

Zoological Society, November 15.—W. T. Blanford, F.R.S., Vice-President, in the chair.—Prof. G. B. Howes, F.R.S., exhibited a series of embryos and five living eggs of the Tuatera Lizard (*Sphenodon punctatus*), which had been sent to him by Dr. A. Dendy, of Christchurch, New Zealand.—Messrs. E. W. L. Holt and L. W. Byrne exhibited specimens and drawings of a small Sucker-fish of the genus *Lepadogaster*, taken at Plymouth, and considered to represent an undescribed species, for which they propose the name *L. stictopteryx*.—Sir G. F. Hampson read a paper giving an account of the classification of the Moths of the subfamily *Pyraustinae* of the family *Pyralidae*, which contained 161 genera. Mr. W. E. de Winton gave an account of the Mammals obtained by Mr. R. McD. Hawker during a recent visit to Somaliland.—Mr. Oldfield Thomas read a paper on the Mammals collected by Mr. J. D. D. La Touche near Kuatun, N.W. Fokien, China, which contained notes on twenty-seven species, two of which, viz., *Vespertilio discolor superans* and *Mus harti*, were described as new.—Mr. G. A. Boulenger, F.R.S., read a memoir entitled "A Revision of the Genera and Species of Fishes of the Family *Mormyridae*," and illustrated it by the exhibition of a fine series of specimens of the family which had been entrusted to him for examination by the authorities of the Congo Free State. According to the author's views the family of *Mormyridae*, as at present known, consisted of eleven genera and seventy-three species, all of which were defined in the paper.—A communication was read from Dr. A. G. Butler, containing a list of the butterflies obtained in the Harar Highlands by Captain H. G. C. Swayne, R.E., one of which (*Mylothris swaynei*) was described as new.—A second communication from Dr. Butler contained an account of a small collection of butterflies made in the Chikala District, British Central Africa, by Mr George Hoare.—A third paper by Dr. Butler contained a list of twenty-one species of butterflies obtained by Mr. R. Crawshay in British East Africa at the end of 1897 and the beginning of 1898.—A communication from Prof. Sydney J. Hickson, F.R.S., contained some notes on the collection of specimens of the genus *Millepora* made by Mr. Stanley J. Gardiner at Funafuti and Rotuma.—Prof. F. Jeffrey Bell communicated a report by Mr. F. P. Bedford on the Holothurians collected by Mr. Gardiner at Funafuti and Rotuma. Eighteen species were enumerated and remarked upon, of which one (*Chiridota intermedia*) was described as new.—Prof. Bell also read a report on the Actinogonidiate Echinoderms brought home by Mr. Gardiner from the same localities. The collection comprised examples of twenty-one species, which were enumerated.—A communication was read from Herr Oscar Neumann containing the description of a new species of Antelope of the genus *Hippotragus* from East Africa, which he proposed to name *H. rufopallidus*.

Royal Meteorological Society, November 16.—Mr. F. C. Bayard, President, in the chair.—A report on experiments upon the exposure of anemometers at different elevations, was presented by the Wind Force Committee. The experiments have been carried out by Mr. W. H. Dines, and Captain Wilson-Barker, on board H.M.S. *Worcester*, off Greenhithe. Five pressure-tube anemometers were employed, the first being at the mizzen royal masthead ; the second and third at the ends of the mizzen topsail yardarm, and the fourth and fifth on iron standards 15 feet above the bulwarks. The results show that the ship itself affected the indications of the lower anemometers, while some low hills and trees, which are a quarter of a mile away from the ship, to the south, and south-west also affected the wind velocity from those quarters. The Committee are of opinion that the general facts deducible from these observations bearing on the situation of instruments for testing wind force are : (1) That they must have a fairly clear exposure to be of much value ; and would appear that for a mile at least all round there should be no hills, or anything higher than the position of the instruments. (2) That on a ship the results may be considered fairly accurately determined by having the instrument 50 feet above the hull, but that on land it will generally be necessary to carry the instruments somewhat higher, to be determined entirely by the local conditions. (3) That no other form of anemometer offers such advantages as the pressure-tube, from the fact that it can be run up and secured easily at this height above a building, and that the pipes and stays can be slight so as to offer no resistance to the wind or cause any deflecting currents. Captain D. Wilson-Barker read a paper giving the results of some observations which he had made on board ship with several hand anemometers with the view of comparing the estimated wind force with that indicated by instruments. Mr. W. Marriott exhibited some lantern slides showing the damage caused by the tornado which burst over Camberwell about 9.30 p.m. on October 29. The damage was confined to an area of about half a mile in extent, and within that space chimney stacks were blown down, houses unroofed, trees uprooted, and windows broken.

Geological Society, November 9.—W. Whitaker, F.R.S., President, in the chair.—On the Palaeozoic radiolarian rocks of New South Wales, by Prof. T. W. Edgeworth David, and E. F. Pittman. Not only in the cherts and siliceous limestones, but also in the jointed claystones which form the prevalent sedimentary rocks of the Tamworth district, radiolaria are found to be distributed in vast numbers. The three chief areas of radiolarian rocks in New South Wales are Bingara, Barraba, and Tamworth, situated in the New England district, between 180 and 270 miles north of Sydney. The fourth area of radiolarian rocks is at the well-known Jenolan caves, about 67 miles due west of Sydney and about 200 miles south-by-west of Tamworth. It is at Tamworth that the radiolarian rocks are developed on a grand scale ; their measured thickness amounts to 9267 feet, after allowing for an immense fault, and neither upward nor downward limit is shown. The rocks consist of jointed claystones, black cherts, lenticular siliceous radiolarian limestones, and coral-limestones. Numerous beds of submarine tuff also occur. The claystones are largely formed of radiolaria. In certain beds of the claystones, and in some of the tuffs as well, impressions of *Lepidodendron australe* are not uncommon ; and beds of radiolarian limestone occur in close proximity to the beds with these plant-remains, and radiolaria moreover abound even in the same rock with the *Lepidodendron*-impressions. In their conclusions the authors point to the remarkably fine grained character of the materials forming the base of the radiolarian cherts, jaspers, and shales, the constituent particles not being more than 0·05–0·025 mm. ($\frac{1}{500}$ to $\frac{1}{1000}$ inch) in diameter. They are of opinion that the radiolaria were deposited in clear sea-water, which, though sufficiently far from land to be beyond the reach of any but the finest sediment, was nevertheless probably not of very considerable depth.—On the radiolaria in the Devonian rocks of New South Wales, by G. J. Hinde, F.R.S. Hand-specimens of the various radiolarian rocks discovered by Messrs. David and Pittman in New South Wales were forwarded to the author, and from them numerous microscopic sections were prepared. Fifty four species belonging to 29 genera have been determined and figured ; all the species and four genera are regarded as new ; excepting a few primitive types of Nassellaria, the forms belong to the Spumellaria. The large majority may be included in the Sphaeroidea and Prunoidea with medullary tests and radial spines. They do not show any near relationship to the radiolaria described from Devonian rocks in Europe, but in some features they resemble the radiolarian faunas of Ordovician age in the south of Scotland, Cornwall, and Cabrières, Languedoc. No other fossils beyond a few simple sponge-spicules and, on two or three horizons, some fragmentary impressions of *Lepidodendron*

australe, have been found in association with the radiolaria. These New South Wales radiolarian deposits are by far the most extensive of any hitherto known, and they are remarkable not only for their great thickness, but also for the manner in which the radiolaria are preserved in the limestones, tuffs, and claystones.

CAMBRIDGE.

Philosophical Society, November 14.—Mr. J. Larmor, President, in the chair.—Orthogenetic variations in the carapace of Chelonia, H. Gadow. Dr. Willey had brought home twenty very young specimens of the Loggerhead Turtle, *Thalassochelys caretta*. This material has been supplemented by the examination of the specimens in the British Museum and the Cambridge Museum of Zoology. In all fifty-six specimens have been examined, consisting of forty-one very young, and others ranging from three inches to the full-grown turtle of about four feet in length of shell. This species exhibits a great amount of variation in the number and size of the epidermal shields which cover the shell. The variations are most numerous in the young, least so in the adult. They can be reduced to a system, each variation representing an atavistic or phyletically older stage, the greater number of shields being the more primitive. The reduction in numbers proceeds in a definite way, until the normal number (namely that which is found in most adult specimens) is reached. Hence the term "orthogenetic variation."—Some points in the morphology of the Enteropneusta, A. Willey. The body-wall of Enteropneusta is characterised externally by annulations determined by the zonary disposition of epidermal glands and separated by interannular grooves. The potentialities of these structures are indicated by the external liver-saccules of Ptychoderidae, which are enlargements of the annulations; and by the dermal pits of Spengelia, which are intergonadial depressions of the interannular grooves. In the Enteropneusta and in the Cephalochorda the gonads are more or less coextensive with the gill-clefts, both being primarily unlimited in number. A theory of gill-slits was developed, according to which gill-slits arose in the interannular depressions, while the gonads were disposed in zones corresponding with the epidermal annulations. The primary function of the gill-slits was the oxygenation of the gonads, their secondary functions being the respiration of the individual. In most cases the gonads have been secondarily emancipated from the gill-clefts in correlation with the elaboration of the vascular system. In the author's opinion the evidence in support of this theory is overwhelming. A collective name, Branchiotrema, was introduced to include all animals which possess gill-slits, whether in the adult or in the embryo.—On *Lepidodendron* from the Calciferous Sandstone of Scotland, A. C. Seward and A. W. Hill. A description was given of the anatomy of an unusually well preserved stem of *Lepidodendron Wunschianum* recently found in a railway cutting at Dalmeny in Linlithgowshire. The stem measures nearly 40 cm. in diameter, the outer bark is well-preserved, but the more delicate middle cortex was destroyed before petrification; the innermost cortex and the central cylinder show remarkably perfect structure. One of the important characters noticed in the stem was the structure of the leaf-trace bundles; these consist of a small strand of xylem more or less completely surrounded by radially disposed rows of secondary elements. The presence of numerous secretory canals in the outer cortex or phelloderm was also referred to as a feature of some interest.

PARIS.

Academy of Sciences, November 21.—M. Wolf in the chair.—On some relations between luminous and chemical energy, and on the displacements between oxygen and the halogen elements, by M. Berthelot. The decomposition of iodic acid into its elements is a reaction which cannot be reversed by sunlight, either dry or in presence of water. The reaction between bromine and water is almost unmeasurable in the dark, but becomes sensible in sunlight. The reverse reaction between hydrobromic acid and oxygen can be shown to take place in sunlight to a small extent.—On the atomicity of boron, by Sir Edward Frankland. Some remarks on the substance described by M. Copaux in the last number of the *Comptes rendus*, arising from the reaction between sodium ethylate and ethyl borate. The formula $(C_2H_5)(ONa).B(OC_2H_5)_3$ would appear to be more probable than that suggested by M. Copaux.—On observations of the Leonid meteors, made from a balloon during the night of November 13 to 14, by M. J. Janssen. Although, by reason of the cloudy state of the sky, the night of November 13 was very unfavourable for observations from the ground, good results were obtained from a balloon at a height of 150 to 200 metres, about twenty-five Leonids being noted.—On the determination of the latitude of the Observatory of Paris by the methods of M. Loewy, by MM. H. Renan, J. Perchot, and W. Ebert. The method used has the advantage over the usual one of measuring the superior and inferior culminations of circumpolar stars of giving results based on night observations only.—Observations of the planet DQ (433), made at the Observatory of Paris, by M. G. Bigourdan.—Elements of the planet DQ (433), calculated by M. G. Fayet.—Observations of Leonids, made on November 14 at the Observatory of Lyons, by M. Ch. André.—On differential systems of which the integration can be reduced to that of total differential equations, by M. Riquier.—An experiment reproducing the properties of magnets by means of combinations of vortices, in air or in water, by M. Ch. Weyher. The bars representing the magnets have a wooden axis, upon which are fastened strong paper vanes along its whole length. A similar bar set in rotation attracts or repels the first, according as the directions of rotation are the same or opposite; the two showing the neutral zone and other properties of magnets.—On the induction machines used as generators or receivers of alternating currents, either simple or polyphase, by M. Maurice Leblanc.—Characterisation of diabetic sugar in urine, by M. Le Goff. The sugar was isolated from the urine by filtration and evaporation in a vacuum to a syrup, from which crystals separated after a fortnight. These crystals were washed with alcohol, then dissolved and treated with animal charcoal, and crystallised out slowly *in vacuo*. The sugar thus obtained had the composition $C_6H_{12}O_6 + \frac{1}{2}H_2O$, for which the rotatory power was $(\alpha)_D = +49^\circ{\cdot}46$. The osazone formed needles, melting at 230°, and oxidation yielded gluconic acid, $(\alpha)_D = +6^\circ{\cdot}53$. These results show that the sugar present in diabetic urine is undoubtedly *d*-glucose.—The utilisation of the phosphoric acid dissolved in the waters of the soil by plants, by M. Th. Schloesing, jun. In sterilised soil, which has been treated with solutions containing all the elements necessary for plant growth except phosphoric acid, plants will not develop naturally, but in presence of solutions containing in addition quantities of phosphates of the order of those contained in arable earth, the plants flourish.—General conclusions on humic coals, by M. C. Eg. Bertrand.—On the constitution of peat, by M. B. Renault. The black peat studied consists of microscopical débris of plants arising from the tougher tissues, such as cuticle, spores, and pollen grains, the other tissues having generally disappeared under diverse influences, especially microbial action. The wood found in peat bogs has undergone a profound modification; its tissue is permeated with the mycelium of microscopic fungi, and numerous micrococci are present.—Artificial production of pearls in the *Haliotis*, by M. Louis Boutan. By the introduction of foreign bodies into *Haliotis*, true pearls can be produced.—On a method of colouring protoplasm by bacterial pigments, by M. L. Matruchot. By growing together on the same medium, a chromogenic bacterium (violet pigment) and a filamentous fungus, an impregnation of the protoplasm of the latter by the pigment can be obtained, and as the colouring matter is selective and is fixed only by a part of the protoplasm, this treatment constitutes a true method of coloration allowing the study of the structure of living protoplasm. This method has been applied by the author to a species of *Mortierella*.—On the black phosphates of the Pyrenees, by M. David Levat. A description of the nature of the deposit, and analyses of the phosphatic nodules. The nodules are black, resembling anthracite in appearance, and consist of nearly pure calcium phosphate.—On the presence of fossil layers containing species of *Physa* and *Limnoea* in the Lower Eocene of Corbières, by M. A. Bresson.—On the parallelism of the Urgonian limestones with the Cephalopod layers in the Dephino-rhodanian region, by M. Victor Paquier.

AMSTERDAM.

Royal Academy of Sciences, October 29.—Prof. van de Sande Bakhuyzen in the chair.—Prof. D. J. Korteweg made some remarks upon the progress in the preparation for the International Catalogue since the Conference of July 1896. Special mention was made of some of the resolutions passed in the Conference of October 11 to 13.—Prof. Winkler made a communication entitled "Attention and Respiration," which will be inserted in the Report of the meeting.—Prof. van der

Waals gave a simple deduction for the formula (p, v, t) for substances whose molecules are compound, and must be considered small bodies of a certain magnitude. In this deduction, which is entirely founded upon the virial equation, a first approximation is given for the variation of the co-volume, and the way is pointed out in which a second approximation might be calculated.—Prof. Lobry de Bruyn made a communication, on behalf of Dr. Steger and himself, concerning the rate of substitution of a nitro-group by an oxyalkyl in accordance with the equation:

$$C_6H_4(NO_2)^2 + NaOCH_3(C_2H_5) = C_6H_4NO_2.OCH_3(C_2H_5) + NaNO_2.$$

It was proved that the nitro-group is more rapidly substituted in paradinitrobenzol than in orthodinitrobenzol, and that sodium methylate acts more slowly than sodium ethylate. It was also determined that the decrease of concentration does not raise the reaction constant, a result opposed to that arrived at by Hecht, Conrad and Brückner as to the formation of ether from alkyl iodide and alkoholate.—Prof. Behrens made a communication concerning some anomalies in Mendeléeff's system, which will also be inserted in the Report of the meeting.—Prof. Hoogewerff and Dr. van Dorp found that the imides of bibasic acids, when heated with methylalcohol, are in many cases transformed into the ethers of amidic acids.—Prof. Kamerlingh Onnes described an open manometer of reduced height, placed in the Leiden Laboratory. The apparatus is composed of fifteen partial manometers of 4 atm., arranged in series. To obtain the requisite pressure in the connecting tubes between the consecutive monometers, compressed gas is introduced into them by needle cocks from a high-pressure cylinder. The apparatus ranges to 60 atmospheres at once, and by two further steps 100 atm. may be reached with part of it.—Dr. Hoek made a communication, on behalf of Mr. M C. Dekhuyzen of Leiden, concerning crater-shaped blood corpuscles (chromocraters). The observations described give ground for the opinion that the chromocrater is an ancestral inheritance from the worms, which has also been preserved in mammals and in man.—Prof. H. G. van de Sande Bakhuyzen presented a communication from Dr. E. F. van de Sande Bakhuyzen, entitled "Some observations on the 14-monthly movement of the terrestrial pole and on the length of its period."—Prof. van der Waals presented a paper on behalf of Mr. N. J. van der Lee, entitled "On the influence of pressure on the critical temperature of solution." Experiments were made with the mixture phenol-water, and the critical temperatures of solution appeared to rise by increased pressure. The rise was about 0·1° for 30 atm. In the case of this mixture theory points to a maximum in the line indicating the pressure of the vapour in contact with the liquid as function of the composition. This conclusion was confirmed by experiments.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 1.

LINNEAN SOCIETY, at 8.—On the Biology of *Agaricus velutipes*, Curt.: R. H. Biffen.—On the Gastric Glands of the Marsupialia: Jas. Johnstone.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Oxidation of Polyhydric Alcohols in presence of Iron: H. J. H. Fenton and H. Jackson.

FRIDAY, DECEMBER 2.

GEOLOGISTS' ASSOCIATION, at 8.—Contributions to the Geology of the Thame Valley: A. M. Davies.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Sunlight Gold-bearing Reef, Lydenberg, Transvaal: Charles Benjamin Saner.

QUEKETT MICROSCOPICAL CLUB, at 8.

MONDAY, DECEMBER 5.

SOCIETY OF ARTS, at 8.—Acetylene: Prof. Vivian B. Lewes.

IMPERIAL INSTITUTE, at 8.30.—A National Photographic Record: Sir Benjamin Stone.

VICTORIA INSTITUTE, at 4.30.—Recent Discoveries on Babylonian Tablets: T. G. Pinches.

TUESDAY, DECEMBER 6.

SOCIETY OF ARTS, at 4.30.—The Yangtse Basin and the British Empire: Archibald Little.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Exhibition of Ethnological Photographs, with Remarks: Rev. H. N Hutchinson.—On the Caves, Shell-Mounds, and Stone Implements of South Africa: George Leith.—On Worked Flints from Griqualand East: J. M. Frames.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Paper to be further discussed: The Effect of Subsidence due to Coal-Workings upon Bridges and other Structures: Stanley Robert Kay.——And, time permitting, Paper to be read with a view to discussion: The Ventilation of Tunnels and Buildings: Francis Fox.

RÖNTGEN SOCIETY, at 8.—A Discussion on Dermatitis, in relation to Röntgen Ray Work, will be introduced by Mr. Ernest Payne and Dr. Walsh.

ROYAL VICTORIA HALL.—Photography in Colours: Child Bayley.

WEDNESDAY, DECEMBER 7.

SOCIETY OF ARTS, at 8.—Egypt and the Sudan, in 1897 and 1898: W. T. Maud.

GEOLOGICAL SOCIETY, at 8.—The Geological Structure of the Southern Malverns and the Adjacent Districts to the West: Prof. T. T. Groom.—The Permian Conglomerates of the Lower Severn Basin: W. W. King.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Use of the Micro-spectroscope, and the Methods of Detecting Blood in Chemical-Legal Investigations: A. H. Allen.

THURSDAY, DECEMBER 8.

ROYAL SOCIETY, at 4.30.

MATHEMATICAL SOCIETY, at 8.—On Groups of the Order p^aq^β: Prof. Burnside, F.R.S.—On Simultaneous Partial Differential Equations: J. E. Campbell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Improvement in Magnetic Space Telegraphy: Prof. Oliver Lodge, F R.S.——And, if time permit: Telegraphy by Magnetic Induction: Sydney Everard.

FRIDAY, DECEMBER 9.

PHYSICAL SOCIETY, at 5.—Longitudinal Vibrations in Solid and Hollow Cylinders; Dr. C. Chree, F.R.S.—On the Thermal Properties of Normal Pentane: J. Rose-Innes and Dr. Sydney Young F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.

BOOKS and PAMPHLETS RECEIVED.

BOOKS.—Nichelatura: I. Ghersi (Milano, Hoepli).—Colorazione e Decorazione dei Metalli: I. Ghersi (Milano, Hoepli).—L'Alluminio: Dr. C. Formenti (Milano, Hoepli).—Ricettario Industriale: I. Ghersi (Milano, Hoepli).—Journal and Proceedings of the Royal Society of New South Wales, 1897. Vol xxxi. (Sydney).—Schantung und Deutsch China: E. von Hesse-Wartegg (Leipzig, Weber).—Congrès National d'Hygiène et de Climatologie Medicale de la Belgique et du Congo, seconde partie, Congo (Bruxelles, Hayez).—Natalité et Démocratie: A. Dumont (Paris, Schleicher).—Human Immortality: Prof. W. James (Constable).—A New Astronomy: Prof. D. P. Todd (Low).—Quaero [some questions in Matter, Energy, Intelligence, and Evolution]: Dr. J. H. Keeling (Taylor).—Illustrated Catalogue of Balances and Weights, &c., Manufactured and Imported by W. and J. George, Ltd. (George).—University College, Sheffield, Calendar, Session 1898–99 (Sheffield).—Repetitorium der Zoologie: Prof. K. Eckstein, Zweite Auflage (Leipzig, Engelmann).—Grundriss der Psychologie: W. Wundt, Dritte Auflage (Leipzig, Engelmann).

PAMPHLETS.—Les Bases de la Météorologie Dynamique: Dr. Hildebrandsson and L. T. de Bort, 1re Livn (Paris, Gauthier-Villars).—Observations et Mesures de la Suède, i. and ii. (Upsala).—Das Mittelenglische Gedicht, the Boke of Cupide, Kritische Ausgabe: Dr. E. Vollmer (Berlin, Ebering).—Incubators and Chicken-Rearing Appliances (Cassell).

CONTENTS.

THURSDAY, DECEMBER 8, 1898.

PHYSIOLOGICAL SELECTION.

Darwin, and after Darwin. By Dr. G. J. Romanes. Pp. viii + 181. (London: Longmans, Green, and Co., 1897.)

THIS third volume concludes the series "Darwin, and after Darwin" of which G. J. Romanes had published the first volume and had planned and mostly written the remaining two, at the time of his death. This volume, as well as the second, has been prepared for the press under the able editorship of Prof. Lloyd Morgan, who has performed a difficult task with conspicuous success. In a brief preface we are told that the first two chapters and the last were in type at the time of the author's death, and remain practically unchanged; while the editor is responsible for the selection and arrangement of the remaining three. The Appendices A and B, bearing upon the controversy with Alfred Russel Wallace, "remain in accordance with the author's expressed injunctions." The frontispiece to the volume is a portrait of the Rev. J. T. Gulick, whose most interesting researches into the variation of the land-shells of the Sandwich Islands led him, independently, to a theory closely similar to that of "physiological selection."

Of all the three volumes of this series, this possesses the greatest personal interest; for it is devoted to the exposition and discussion of the evidence for and against the much debated hypothesis of physiological selection, which, although never widely accepted, always remained dear to its creator. The present volume, which possesses many advantages over the original account of the hypothesis published in the Linnean Society's Journal, will do much to enable biologists clearly to grasp the author's meaning.

The two first chapters deal with "isolation" in general, a principle which was given a position of the utmost importance by the author, who regarded not only his own physiological selection, but natural selection itself as a special form of isolation. The third, fourth and fifth chapters deal with "physiological selection" and its evidences; the sixth again returns to "isolation" as a factor in "organic evolution," and also contains the "general conclusions." Appendix A contains Mr. Gulick's criticism of Mr. Wallace's views on physiological selection; B, an examination by Mr. Fletcher Moulton of a calculation by Mr. Wallace on the same subject; C, "some extracts from the author's note-book."

In the discussion of isolation the author first distinguishes between *indiscriminate* isolation such as would be produced by some sudden geographical change separating the individuals of a species into two detachments, and *discriminate* isolation such as would be caused by a part of the species seeking some new area, or some different habitat on the same area. While Mr. Gulick recognised this distinction under the terms "separate breeding" and "segregate breeding," the author suggests "apogamy" and "homogamy." He says, moreover, "with the exception of Mr. Gulick, I cannot find that any other writer has hitherto stated this supremely important distinction between isolation as discriminate and indiscriminate." But the classes of facts to which he alludes are distinguished by every writer and thinker on evolution: the only difference being that the author is peculiar in making isolation the basis of his classification. Other writers have used the term "isolation" for the cases in which separation is the primary and essential factor, viz. for "indiscriminate isolation" only; "discriminate isolation" they have classified as "natural selection" or as "Lamarckian evolution," as the case may be, the separation being regarded as a secondary result.

The whole discussion of isolation in the exalted position in which it is placed by the author ("the whole theory of organic evolution becomes neither more nor less than . . . a theory of the causes which lead to discriminate isolation," p. 6) is interesting and suggestive, and a large part of it convincing. It is also for the most part clear and lucid in treatment, although sentences occur which seem unnecessarily to demand the strained attention of the reader. Thus after arguing that diversification of character is *promoted* but never *originated* by natural selection, the author concludes, in the following complicated passage:

> "Therefore the change must in all cases have been due, in the first instance, to some other form of isolation than the superadded form which afterwards arose from superior fitness in the possession of superior benefit—although, so long as the prior form of isolation endured, or continued to furnish the necessary condition to the co-operation of the survival of the fittest, survival of the fittest would have continued to increase the divergence of character in as many ramifying lines as there were thus given to its action separate cases of isolation by other means" (p. 32).

The ideas sought to be conveyed in this quotation are not difficult of comprehension, but the form is such that they become intelligible only with effort.

Physiological selection is defined by the author at the opening of the third chapter as "that form of isolation which arises in consequence of mutual infertility between the members of any group of organisms and those of all other similarly isolated groups occupying simultaneously the same area." The two great difficulties in the way of natural selection as a sufficient explanation of the origin of species are held to be the difference between domesticated varieties and natural species in respect to cross fertility, and "the fact that natural selection cannot possibly give rise to polytypic as distinguished from monotypic evolution." The former difficulty has long been felt, and it was the great logical flaw which always prevented Huxley from declaring his entire conviction in the soundness of the theory. The author is certainly right in claiming for physiological selection that it would tend towards the removal of this difficulty. As to the second difficulty the majority of Darwinians will not be convinced by the author's reasons for thus limiting the power and scope of natural selection.

The conception of physiological selection—the idea that the differentiation of species begins with infertility instead of ending with it—is here shown to have arisen independently in many minds, having been first mentioned by Belt (1874), then by Catchpool (1884), Romanes (1886), and Gulick (1887).

To the present writer it has always appeared that the suggestion is an extremely interesting and ingenious one, the chief objection being the immense difficulty in proving that it actually exists or has ever existed as an operative principle. If it exists, then much that is claimed for it would follow. We know that geographical isolation is followed by differentiation, and many evolutionists are prepared to admit that some of the minor differences thus produced may be independent of natural selection. Most naturalists would probably be inclined thus to explain the differences between the land-shells of adjacent valleys in the Sandwich Islands as described by Gulick. Those who believe in physiological selection consider that what is here brought about through the prevention of interbreeding by geographical barriers, is produced on continuously peopled areas by the physiological barrier of infertility.

This conclusion is capable of being tested to a certain extent by an investigation of the degree of infertility between species which are known to have been produced in the former manner and those (of approximately equal differentiation) which are believed to have been produced in the latter. Apart from its application to the present controversy such an inquiry would be of great interest in itself.

The results of such an investigation would be far more convincing than the elaborate and often very ingenious arguments of the writer, many of which are capable of an immediate and satisfactory answer. For instance on pp. 48, 49, he asks how it is that the reproductive system is always affected "in the same peculiar way," viz. so as to produce mutual sterility, between different species of all kinds, animal and vegetable, separated by morphological differences of infinite variety. It is evident that he regards this question as unanswerable except on the view that the infertility is the invariable precursor and condition of the differentiation. But the facts can readily be explained otherwise. Mutual fertility depends upon the exact relotionship of two extraordinarily complex bodies, the germ-cells of male and female; it depends upon a reciprocal adjustment of almost infinite precision. Single individual variations receding from the necessary precision continually arise, but are infallibly exterminated. Such variations are not to be looked upon as due to a single and uniform change in the complex material of the germ-substance. The opposite point of view is the truer: mutual fertility is due to a single and uniform constitution rigidly kept within the narrowest limits, while a minute change of constitution *in any direction* means infertility. Mutual infertility is, in fact, but the single external indication of numberless changes of constitution. The necessary precision of adjustment of the male to the female germ-substance is only kept up in the species by unremitting selection, and there is no cause for surprise that it should cease when selection is no longer forthcoming for its support. These considerations seem at first sight to indicate that mutual fertility between domestic breeds is a matter for greater wonder than the infertility between natural species. We cease to wonder, however, when we reflect upon the length of time which must have elapsed since the separation of natural species such as the horse and ass, which are nevertheless fertile when crossed, although their hybrid progeny is sterile. Since this is the case the mutual fertility of our modern domestic races, so far as it has been proved to exist, is only what we should have been led to expect. In this relationship the present writer has often considered that further experiments upon these latter would be of great value, especially in the case of races in which the morphological differences have been carried to a very high degree—so much so, indeed, that artificial fertilisation would probably be necessary.

The argument which has been met in the last paragraph is evidently one on which the greatest stress is laid. Thus we again read on p. 51 of "this one peculiarity of the reproductive system," viz. mutual infertility; and on pp. 52, 53, it is made a chief support for the hypothesis of physiological selection, a good brief account of which will here be found. Throughout the whole work we meet with the same insistence on "this constant primary distinction," "the same peculiar change," &c., as one main foundation for the hypothesis.

If space had permitted, many other interesting points raised in this volume might have been discussed. It is of great service to the student of evolution that the hypothesis of physiological selection, the arguments for it and evidence which supports it, should have been brought forward in so readable a form. The work is printed in pleasant type, and has been so carefully seen through the press, that there are practically no printer's mistakes.

E. B. P.

THE THEORY OF GROUPS.

Theory of Groups of Finite Order. By W. Burnside, M.A., F.R.S. Pp. xvi + 388. (Cambridge University Press, 1897.)

THE theory of groups of finite order is one to which in very recent times the attention of mathematicians has again and again been directed. Until a little time ago any one who wished to become acquainted with the elements of the theory would have been referred to J. Serret's "Algebra," to C. Jordan's comprehensive "Traité des substitutions," and to E. Netto's introductory work on the same subject. No one who takes account of the time at which it was written will wish to depreciate the merits of the first of these, but the chapters dealing with groups consist of a series of extracts reproduced from the original memoirs of the masters to whom we owe this branch of mathematics: these extracts are chosen with all the knowledge of an expert as to what should be chosen, but are not worked up. C. Jordan brings together an overpowering wealth of material, which for the most part has its origin in his own researches; but there can scarcely ever have been any one who would be in a position to work through the treatise from beginning to end; or who could without guidance from some other source separate the fundamental portions from the mass of detail. Lastly, Netto's book on substitutions is now fifteen years old; it still forms a useful introduction to the subject, but it goes no further than that.

The most modern treatises on algebra mete out varying treatment to the theory of groups. Netto leaves it on one side altogether; Drach makes the interesting experiment of attempting to build up the elements of

algebra by a consecutive formulation of Kronecker's abstractions without using the notion of a limit, and restricts himself in the process to those parts of the group-theory that are necessary for his purpose; Vogt provides for French readers an equivalent of what Netto, in his older book, and Netto's translators, Battaglini and Cole, had given to Germans, French, and English; in Weber's great treatise the theory appears as an important aspect, but still only an aspect, of the problem of algebra. For all these books the theory of groups is a means to an end, or rather to one of multifarious ends which it can be called upon to serve, viz. the algebraic solution of equations.

But in course of time the theory of groups has ever more and more emancipated itself from algebra, whose servant it originally was. Years ago Cayley threw out, though he did not develop, the fundamental idea that the notion of a group, in and for itself, is in no way bound up with permutations and substitutions, but arises whenever the effect of two operations performed successively upon an object is the same as that of a single operation of the same kind. In the general theory of groups thus founded, groups of finite order form a well-marked division. To bring together the great mass of single results yielded by exploring this division of the theory from different sides, to take a comprehensive view of them, and to exhibit them in a well-digested form, is the problem that has been attempted for the first time in the book before us, and it is solved in the happiest manner.

The author does not push abstraction to the point of banishing from his book all concrete methods of representation of groups. He frequently uses properties of groups of substitutions, in particular, not merely with a view to making results plain to intuition, but also for the deduction from them of properties of groups in the abstract. He himself asks the question why other particular methods of representation of a group, *e.g.* by means of homogeneous linear transformations, are not employed in a similar way, and he answers it, as I think rightly, in the words "that, while in the present state of our knowledge, many results in the pure theory are arrived at most readily by dealing with properties of substitution groups, it would be difficult to find a result that could be most directly obtained by the consideration of groups of linear transformations."

Believing that familiarity with symbolical calculations concerning interchanges of letters is not to be assumed on the part of his countrymen, the author gives a sketch of this theory in a short first chapter. The second chapter begins with Cayley's abstract definition, cited above, and carries the development of the general properties of a group as far as Dyck's theorem to the effect that every group of finite order N can be represented as a group of interchanges of N symbols. The third chapter develops the notions: sub-group, self-conjugate sub-group, simple group, isomorphism, factor groups. Then follow in chapters four and five special investigations relating to Abelian groups and to groups whose order is a prime number; in the latter the author has placed a series of results of his own researches. The sixth chapter brings us back with Sylow's theorem to the general theory, and the pivot of the theory is found, in chapter seven, in the theorems on the composition-series of a group. The three following chapters are especially concerned with groups of substitutions, with the questions of their transitivity and primitivity; in addition to the general theorems, they contain a great number of completed researches on special groups and types of groups; some of these are of intrinsic interest, and others serve as vivid illustrations of the general theory. The eleventh chapter treats of the isomorphism of a group with itself on the lines followed by Hölder and Frobenius. In the twelfth and thirteenth chapters is explained the method of representation of a group which was developed in a general manner by Dyck, viz. the representation by means of geometrical transformations of a surface divided into regions, and especially by the transformations effected by linear relations between complex variables. An older method, due to Cayley, of representation by coloured diagrams leads in simple cases to results easier to appreciate at a glance; this method also is here expounded and illustrated by a beautifully executed coloured plate. The fourteenth chapter treats of the representation of a group by means of systems of linear congruences. There is a certain incongruity in the fact that while this is inserted, the representation by means of systems of linear equations is omitted; but the theory of this method would by itself furnish material for a second book as large as the one before us. Perhaps the author will some day give us such a book. On the other hand we find here the extension of the theory named to congruences holding among Galois' imaginaries. This was cultivated in his time by E. Mathieu, and has been taken up recently by E. H. Moore and the author of this treatise, in whose hands it has led, among other remarkable results, to the knowledge of a new series of types of finite groups. Finally the last chapter gives an account of the most modern enumerations of types of groups, in particular of simple groups of an order which can be expressed in a prescribed manner as a product of primes.

The author has not attempted to give historical references concerning the discovery of the older theorems; but for the more modern literature, of about the last twenty years, and right up to the time of publication, his references are full and trustworthy.

In respect of the completeness and exactness of its matter, the work fills in a very acceptable manner a gap in the literature of mathematics, and not merely of mathematics in England. It brings to the special subject a great wealth of material for the widening and deepening of knowledge; while at the same time beginners, under expert guidance, will be able to make a profitable use of it.

H. Burkhardt.

OUR BOOK SHELF.

Radiation: an Elementary Treatise on Electro-magnetic Radiation, and on Rontgen and Cathode Rays. By H. H. Francis Hyndman, B.Sc. (Lond.). With a Preface by Prof. Silvanus P. Thompson, D.Sc., F.R.S. Pp. xviii + 307. (London: Swan Sonnenschein and Co., Ltd. New York: The Macmillan Co., 1898.)

The author considers chiefly those portions of the subject which are somewhat neglected in most books, and in addition deals with the results of some of the

more recent investigations. Brief outlines are, however, given of those parts that are not especially treated, in order to maintain continuity and allow of a direct comparison of the properties of the different radiations. Many references are given to original sources, which enable the reader to extend more readily the narrow limits of the book.

The treatise contains an account of a large amount of interesting work, but it can scarcely be expected that one not perfectly familiar with the subject can follow the ideas so briefly expressed in many places.

Throughout the volume we are confronted with a considerable number of misleading and erroneous statements, the nature of which can be seen from a few examples. For instance, on p. 255 it is stated :—"That the rays do not themselves act as conductors seems proved, for they can pass between bodies of very different potentials if these are not already connected by lines of force." Any comment on this is superfluous.

On p. 198 we read :—"The cathode rays possess the same power as the ultra-violet and the X-rays, of causing those gases which they traverse to become conductors of electricity." All careful experiments, however, show that ultra-violet light in traversing a gas does not produce any conductivity.

Again, on p. 259 it is stated that the charge carried by the ions in X-ray conduction can be calculated from the values of the saturation current and the time required for the conductivity of the gas to sink to half of its value. Such a calculation is not possible.

On p. 254, in regard to conduction produced by the passage of X-rays through bodies, we read that "paraffin, wax, sulphur, ebonite, mica, and all gases become conductors." It is now generally believed, however, that solid insulators are not made to conduct by the rays, and the author ignores this side of the question.

Strict accuracy in the facts presented is an essential of every scientific treatise, as the harm produced by the inception of erroneous ideas cannot be over-estimated.

J. Z.

Four-footed Americans and their Kin. By Mabel Osgood Wright. Pp. xv + 432 ; illustrated. (London : Macmillan and Co., Ltd. New York : The Macmillan Company, 1898.)

WHATEVER difference of opinion may obtain as to whether the title of this little volume is the best that could have been found, or whether the "Mr. Barlow" style of "Sanford and Merton" is the most suitable for popular natural history, there can be no hesitation in according the highest praise to the exquisite illustrations which form its most attractive feature. In addition to being in every way artistic productions these, so far as we can judge, are absolutely life-like ; portraying the animals not only among their natural surroundings, but also in characteristic attitudes. Where none are bad, and all attain a high standard of excellence, it is almost invidious to make a selection ; but two of the illustrations which especially strike our fancy are the wood-hare on p. 141, and the little striped skunk on p. 181. It is rare, indeed, to meet with illustrations of such a high class, and these alone ought to give the book a large sale ; while the artist, Mr. E. S. Thompson, ought to obtain a world-wide reputation as a delineator of animal life.

But it is not on the illustrations alone that the book has to depend for popularity ; as, allowing for certain peculiarities in the style, the descriptions of the habits of the various animals mentioned are for the most part well written and entertaining. A classified synopsis at the end gives a clue to the identification of the species described ; and in this connection it is important to notice that in nearly all cases the author is thoroughly up to date as regards nomenclature. As changes in nomenclature have been necessary, it is most desirable that they should be adopted by popular writers. We must, however, take leave to object to the title of "Beef or Meat Family" for the *Bovidae*, as also of "Antelope Family" for the Prongbuck, and of "Leapers" for the *Leporidae*. Since, too, the *Viverridae* are conspicuous by their absence in America, the misnomer of "Civet-cat" is decidedly objectionable for the Cacomistle (*Bassariscus*), whose inclusion among the "Cousins of Cats" is scarcely warranted by the facts. As a Christmas present to all young persons interested in animals, the work may be confidently recommended.

R. L.

Electricity made Easy, by Simple Language and Copious Illustration. By Edwin J. Houston, Ph.D., and Arthur E. Kennelly, Sc.D. Pp. 348. (London : Swan Sonnenschein and Co., Ltd., 1898.)

SIMPLE descriptions and explanations of electrical appliances met in every-day life are given in this volume. Facts with regard to the nature and functions of electric mains, the distribution of currents, generating stations, the principles of incandescent and arc lighting, measurement of electric supply, electric bells, telegraphy, telephones, and other things concerned in the production and uses of electricity are stated in the simplest of words. Illustrations are given of the external and internal appearance of many of the appliances described. These pictures are, perhaps, a trifle too numerous, for they tend to give the volume the character of a catalogue of electric fittings.

The comparison of the flow of water with the flow of electricity is a useful one ; but there is a danger that the reader will carry the analogy too far. On p. 30, for instance, we read that electricity "flows through wires very much like water or gas flows through pipes, but flows through a solid wire as readily as through a tubular wire of the same weight." Brief statements of this kind are frequently the cause of serious misconceptions as to the nature of electricity.

Differential and Integral Calculus for Technical Schools and Colleges. By P. A. Lambert, M.A., Assistant-Professor of Mathematics, Lehigh University. Pp. x + 245. (New York : The Macmillan Company. London : Macmillan and Co., Ltd., 1898.)

THE first hundred pages of this book are occupied with the differentiation and integration of simple algebraic functions, including easy applications to geometry, and here and there a mechanical problem is set amongst the examples.

Then come chapters involving trigonometrical functions, and logarithmic and exponential functions, followed by a chapter containing applications to mass centres and moments of inertia. The next two chapters deal with expansions and applications of Taylor's theorem, and the last forty pages of the work are devoted to an outline discussion of certain simple classes of differential equations.

There are some good features in the book considered as an introductory text-book for ordinary school use where a good deal of supplementary oral teaching would be given. Thus the statement of methods and the proofs, or indications of proof, are clearly worded ; the examples are easy and straightforward, and in two or three cases distinctly fresh illustrations appear.

But the general treatment is very superficial : far too much ground is covered ; there is an appearance of easy progress produced by the avoiding of the real difficulties which occur in the practical applications of the calculus. In fact, it is quite misleading to describe the work as specially adapted for technical schools and colleges. No instructor of an English technical class would consider this handbook an adequate introduction to the application of the calculus to physics or engineering.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Range of the Garefowl (Alca impennis).

IN 1856 the late Dr. Gray obtained for the British Museum an example of this extinct species from the collection of the late Prof. van Lidth de Jeude of Utrecht, and for some reason unknown to me had the locality "Labrador" painted on its stand. As I had been informed with certainty by the late Prof. J. T. Reinhardt that this specimen was one of those sent to Copenhagen from Iceland, I corrected the error in *The Natural History Review* of October 1865 (vol. v. p. 473, note), and the correction has since been generally accepted. It is therefore with some regret that I find the old error repeated in the recently published volume of the "Catalogue of the Birds in the British Museum" (vol. xxvi. p. 564), and the error is rather a serious one in the absence of evidence of the species having inhabited the coast of Labrador, as well as that of any skin of proved Transatlantic origin. I may also mention that on the same page of the "Catalogue," the date of Bullock's Orcadian specimen is wrongly given as 1812 instead of 1813.

ALFRED NEWTON.

Magdalene College, Cambridge, December 3.

Asymmetry and Vitalism.

THIS must be my last word on this subject, and it is only written because Prof. Japp asks me to correct him if I consider him wrong in his interpretation of my illustration of the separation of tetrahedral atoms. I apologise to him as a chemist if I used the word "compound" where I ought to have used "substance" or "mixture," although it seems to me Messrs. Kipling and Pope use the word compound in a perilously like sense in the eighth paragraph of their letter. The use of the word has nothing to do with the main argument, the chance production of the optically active "mixture," and then the production from the "mixture" of the optically active "compound" with only one enantiomorph. By the by, will Prof. Japp guarantee that all vital optically active substances are "compounds" in this sense, and not largely preponderating "mixtures"? I only put the question, rather irresponsibly in passing, owing to something a distinguished biologist let fall in my presence the other day. I am quite prepared to be told that this is as well demonstrated as the law of gravity. Now as to my illustration, I was certainly thinking of a spin from rest so that the tetrahedra start with an impulse relative to the fluid and further experience its resistance relative to their motion. Let us take the *simplest* possible case for an example. Suppose Z′ somewhat larger than Y′, both considerably larger than X′ and H negligible to a first approximation. Then I should expect Y′ to set itself nearly in the wake of Z′, and X′ to turn in towards the axis. Thus Z′, Y′, X′ would be in a plane perpendicular to the axis; this would bring H above for one type of tetrahedron and below for the other type, or we have differentiated the positions of right- and left-handed tetrahedra. However, I do not lay stress on the illustration, for whatever we do now to separate left- and right-handed tetrahedra, I take will be asymmetrical relative to the sense of the original spin, and accordingly if I am correct, I am only inventing a clumsy illustration of non-vital asymmetric force, of which Prof. Fitzgerald has already given a much better illustration in the earth's rotation. Will any physicist having the apparatus at his disposal kindly spin with great but *irregular* speed a couple of tetrahedra in a viscous fluid, the axis of the churn being horizontal? The balls at the angles of the tetrahedra, being arranged right- and left-handed and of masses somewhat as above, we should be able to settle whether a differentiation of position would or would not take place. I should not be surprised to hear that the two tetrahedra moved to opposite ends of the churn.

KARL PEARSON.

A Shag's Meal.

THE following observation on the habits of the shag (*Phalacrocorax graculus*), which frequents our coasts, is probably of interest in itself and not without bearing on the subject-matter of Mr. Lowe's letter (November 24)

On August 15 last, when at anchor in Wicklow harbour, in the course of a cruise, we noticed a shag alight upon the water at a short distance from our yacht. It was a very calm, bright day. What follows occurred within a distance of a cable's length or thereabouts of our boat; and as I observed the proceedings throughout by the help of a powerful "triëder binocle" (× 9) of Goerz, and my companion, Dr. H. H. Dixon, possesses unusually keen sight and closely followed the events, there is no doubt as to the reality of what is here recorded.

The shag, after swimming about for a little, dived once or twice—apparently fruitlessly—but finally appeared with a large eel in his beak. The eel was big and strong, and twisted into the form of a figure 8, evidently an awkward morsel. The bird kept snapping and shifting it in his beak, till at length with a few violent gulps it swallowed the eel, the latter evidently going down alive. It was to be inferred, in fact, that the shag was not happy with so large a live eel in his crop, for he swam restlessly about, twisting and stretching his neck incessantly. Presently he dived again, was down perhaps twenty seconds, and came up with an eel as large as the first one. This writhed and twisted like its predecessor, and, after much snapping, finally suffered the same fate. The same uneasiness was displayed by the bird, and the bird once more dived.

Dixon and I were expressing some surprise at the rapidity with which our friend had caught the two eels, and also at his very considerable capacity to hold two such large eels—certainly not less than 15 inches long each—when the bird reappeared bearing a third eel, as big as its predecessors and engaged in the same violent resistance. The same snapping, same gulping, same uneasiness and down for a dive once again! This was the third eel.

While we were taking sympathetic breaths with the insatiable shag, the latter reappeared—yet again with a 15-inch eel. Evidently the harbour was so full of 15-inch eels that a shag had only to dive to pick one up. It was also evident that no language could be too strong in which to condemn such unmeasured license. Four 15-inch eels—all swallowed alive—within the space of about four minutes!

But this was only the beginning, as will presently appear. The bird went down again almost immediately after the fourth. We determined to keep careful count and, if possible, get the measure, in eels, of a shag's capacity. Would he bring up another? Yes, there he was again with another 15-inch eel! A very vigorous eel—just like the others in size and appearance, and swallowed in the same manner, after about 30 seconds' resistance. This made five eels.

The question now arose as to what would be the end of this bird. Was he going to die the death of King Henry I. before our eyes? We called him King Henry to distinguish him from other shags.

To make a long story short, we counted *twelve* eels!—all stout 15-inchers. The twelfth seemed, perhaps, rather feebler than the others, but still it nearly got away. For King Henry dropped it in a too vigorous snap, and only recovered it by a prompt plunge forwards. H.R.H. now seemed to reflect that this last misadventure was a warning, swallowed his twelfth, and took flight; disappearing in an easterly direction whence he had come.

There is, of course, only one explanation of all this: the twelve eels were one and the same eel. To suppose the bird caught and devoured twelve eels of this size in as many minutes appears to us incredible. His final appearance as he flew astern of us betrayed no signs of surfeit. He would have had at least two pounds' weight of eel within had he really eaten twelve such eels.

The peculiar procedure of ejecting the prey under water appears very remarkable. Perhaps the head-downward attitude of diving is requisite to effect this.

Has this mode of weakening or playing with his prey been recorded of the shag (or, indeed, of any animal) previously?

Trinity College, Dublin, November 27. J. JOLY.

Periodic Tides.

ATTENTION has lately been called by Mr. H. C. Russell, of Sydney Observatory, to what may be termed a tide of short period, which he has detected in the enclosed harbour of Sydney.

Mr. Russell traces a connection between this interesting

phenomenon and certain meteorological conditions obtaining at a distance. Looking to the position of Sydney Harbour, it is only natural that we should expect to find the origin of these undulations in the open ocean; but experience of similar phenomena in another part of the world leads me to think that the cause, whether meteorological or not, must be sought nearer at hand.

My attention was first drawn to these curious fluctuations of sea level when golf playing on the low sands at the head of the landlocked harbour of Lemnos in the Greek archipelago, on August 9, 1895. I noticed that the current in the shallow streams communicating with the sea appeared to reverse at intervals of about a quarter of an hour, without any apparent cause. On returning to Malta I inquired if anything similar had been noticed there, and in consequence of information then received, I commenced some observations on my own account.

It is a matter of common knowledge to naval officers and others concerned, that the irregular variations of sea level in the Maltese inlets are at times sufficiently great to completely mask the slight lunar tide: and that the Port Officials are in the habit of insisting on a considerable margin of depth before permitting vessels to pass over the sills of the dry docks. These extra tidal variations of sea level have been ascribed to various causes, such as the direction and strength of prevailing winds, currents setting towards the mouth of the inlet, or to what is vaguely called the natural period of the harbour. My observations showed conclusively that there is at certain times in Malta Grand Harbour a perfectly regular ebb and flow with a period of twenty-three minutes; about the same period obtaining in Sydney Harbour, which Mr. Russell gives as twenty-six minutes.

My observations were made in the neighbourhood of Magazine Point, about two-thirds of the distance from the sea to the head of Valetta Harbour, the width across the harbour at this spot being little more than 300 yards. On May 7, 1896, the to-and-fro movement of the water was very remarkable, being continuous from 8 a.m. till 2 p.m. Between these hours the water in this part of the harbour rose and fell with the utmost regularity, the range being about 15 inches and the interval between successive high waters about twenty-three minutes. This variation of water level at the head of the harbour caused a strong current, which changed its direction every eleven or twelve minutes. The regular reversal of current was indicated in a remarkable manner by the behaviour of the spar buoy moored off Magazine Point. The weather during the morning was normally fine—that is to say, nearly calm inside the harbour, with a light but gradually increasing sea breeze outside.

The similarity in the period of the undulations observed at Sydney and at Malta suggests a common origin.

If, however, as Mr. Russell seems to think, the Sydney waves are due to the combined effect of wind and current influences exerted at a considerable distance, this similarity of period can be little more than a curious coincidence. Long period undulations, such as these under consideration, could hardly be originated by the wind and current systems of the Mediterranean, which, at the given time of the year, at all events, are feeble and comparatively local in their effects.

If, on the other hand, we for a moment suppose that the action of local currents and sea breezes, driving a head of water into the inlet, results in the establishment of regular oscillatory movements, is it probable that the "natural periods" of two harbours, differing so much in area as do those of Sydney and Valetta, would be so nearly equal?

Considerations such as these seem to indicate that the cause of these "short period" tides is one and the same, notwithstanding that they occur on opposite sides of the world and apparently under different conditions; and also that their real origin has not yet been ascertained.

Trustworthy observations in landlocked bays and harbours are still very much wanted, and it may be that until such are available in a greater degree than at present, the whole subject of tidal irregularity will remain more or less obscure.

In conclusion, sir, permit me to express the hope that you will afford space for the discussion of this interesting subject in your columns by those who are able to deal with it. In this way we may hope to ascertain whether any trace of earth movements occurring at short and regular intervals has been noticed near the localities and at the times mentioned: for it is just possible the true cause of these remarkable tides may be one hitherto unsuspected. ANTHONY S. THOMSON.

Concerning the Thermodynamic Correction for an Air Thermometer.

IT seems noteworthy not only that the theoretical investigation on this subject, given in Maxwell's "Theory of Heat" and Tait's "Heat," is fallacious, as has been pointed out by Mr. Rose-Innes in his letter which appeared in your issue of May 26, but that there is no indication in either of these text books that the result given is not in accordance with the experimental facts. The investigation in question, which is practically the same as that first given by Lord Kelvin before the experiments were performed, leads to the result that the cooling effect should be proportional to the difference of the logarithms of the pressures before and after passing the plug, instead of proportional to the difference of the pressures themselves, as was actually found to be the case; the discrepancy was, of course, noted by the experimenters. The methods used in all the theoretical discussions in Lord Kelvin's papers on this subject prior to the final one in Part iv. of the papers "On the Thermal Effects of Fluids in Motion," seem equally open to objection. The numerical results derived by the last method, which seems perfectly sound, were given apparently for the first time in the article "Heat" in the "Encyclopaedia Britannica"; the investigation and results are reproduced in Preston's "Theory of Heat," and substantially in Parker's "Thermodynamics." The correction obtained to the number representing the temperature of melting ice on the absolute scale by this method was + ·70, the previous methods giving in succession + ·83, − ·03 and + ·87; the uncorrected estimate finally used was also different from that taken at first. W. McF. ORR.

Royal College of Science, Dublin, November 25.

Science in Elementary Schools.

THE report on the teaching of science in elementary schools, drawn up by the British Association Committee, and published in your issue of November 24, is likely to be unintentionally misleading. The following paragraph leaves out of consideration an important modifying cause:—"It was remarked in the last report that the increased teaching of scientific specific subjects in the higher standards is the natural consequence of the greater attention paid to natural science in the lower part of the schools. The following table shows the correctness of this inference." [Then follows a table showing the gradual increase in the number of children examined in specific subjects.]

The Directory of the Science and Art Department for 1897 contained a new regulation to the effect that "no student may be registered for a grant for day attendance under the Department of Science and Art—except the grants for elementary drawing and manual instruction—whose name is on the register for day attendance under the English or Scotch Education Departments, or the National Board of Education, Ireland." The result of this has been that large classes under the Science and Art Department in such subjects as physiography and hygiene, composed of Standard VII. children in elementary schools, were discontinued; and, possibly with a view to replacing part of the grant thereby lost, specific subjects were taken up in connection with the Education Department. A considerable increase in the number of children taking specific subjects may be anticipated for the years 1897-8 and 1898-9, but the reason will scarcely be that put forward by the British Association Committee, but rather the new regulation from South Kensington. A. T. SIMMONS.

London.

THE new regulation of the Science and Art Department, quoted in Mr. Simmons's letter, was issued only in 1897: it was impossible, therefore, that the effect of it on the day schools could be shown in the tables that form part of our last report. The results may begin to show themselves in the report of next year, but only as an addition to the increase due to the greater attention still being paid to natural science in the lower part of the schools. It is to be hoped that this aggregate increase will be a large one; but it will evidently be very difficult to assign to each cause its proper proportion. J. H. GLADSTONE.

A Remedy for Bookworms.

IN NATURE, No. 1506, vol. lviii., of September 8, there is a review (p. 435) of a book, "Facts about Bookworms," by the Rev. J. F. X. O'Connor, S.J., which concludes by lamenting there is no panacea for these book pests.

Here, in tropical Queensland, I was much troubled by various borers, and "silver-fish"; but for the latter, which apparently only devour the glaze on paper, and paste, I found a new remedy in adding alum to paste, and keeping glazed writing paper in tin boxes.

For the former a solution of *corrosive sublimate and thymol in alcohol*, appears to be an effectual remedy, though probably it would require to be re-applied from time to time; but certainly all books dressed by me with this solution inside and outside the covers, have never been touched since.

The newspaper extract (paper and date unknown), from which I obtained the information, read as follows:—"Surgeon-General Bidie, in the *Fishing Gazette*, recommends a solution of corrosive sublimate and thymol as a perfect protection for books from the ravages of bookworms and other insect pests, having tested it in tropical countries where the termite and the larvae of innumerable creatures batten upon everything eatable, from door-posts to bottle corks."

I have certainly found this remedy thoroughly efficacious, and think it deserves to be more widely known.

J. EWEN DAVIDSON.

Branscombe, Mackay, Queensland, October 20.

The Properties of Liquid Mixtures.

IN the abstract of my communication to the Physical Society in connection with Mr. R. A. Lehfeldt's paper on the above subject (NATURE, December 1, p. 116), the most probable explanation of the fact that, when American petroleum is distilled, the benzene comes over at about 65° instead of 80°, is stated to be that "benzene and hexane behave, as regards distillation, *like miscible liquids*." This should read "*like partially miscible liquids*."

The two liquids are, in fact, miscible in all proportions, and the point is that, in certain respects, they behave as though they were only partially miscible.

SYDNEY YOUNG.

December 6.

The Mildness of the Season.

As an instance of the mildness of the season, I may state that on Sunday, November 27, I gathered five ripe strawberries out of my kitchen garden; and that a considerable number of strawberry plants still show signs of flower. Moreover, the leaves of several deciduous trees, such as peaches, lilacs, &c., which are planted in sheltered situations, are still perfectly green; whilst many others are only just beginning to assume their autumn tints. I have also gathered several rosebuds this morning.

In this part of England all the leaves have usually fallen by the end of November. In fact, in ordinary seasons, the elms (which shed their leaves late) are quite leafless by the middle of the month.

A. B. BASSET.

Fledborough Hall, Holyport, Berks, November 29.

Iridescent Clouds.

THERE was a fine example of clouds showing iridescence on December 4, from 8.50 to 9.5 a.m., in the south-eastern sky. It occurred on a large white cumulo-maculo cloud, the iridescence being confined to the upper and lower margins, which were much striated.

This was at first the same period *after sunrise* as I have commonly observed the phenomenon to occur *before sunset*, *i.e.* at about an hour's distance from each event (*vide* my letter on the subject, NATURE, vol. lviii., p. 390). I have not seen it before in the morning.

E. ARMITAGE.

Dadnor, Herefordshire, December 5.

The Origin of the Aurora Spectrum.

WITH reference to the question as to whether there is any auroral line in the position of the krypton line about 587, the nearest lines to this that have been observed in the aurora appear to be 5765 and 595 observed by Gyllenskiöld. His observations were only rough, but the question is whether they are near enough to the krypton line for either of them to be the same as it. If there is any auroral line about 556, it is likely that the great brilliancy of that at 557 would account for its not having been seen.

T. W. BACKHOUSE.

West Hendon House, Sunderland, November 30.

SVEN HEDIN'S "THROUGH ASIA."[1]

CAPTAIN FRANK YOUNGHUSBAND prefaced his charming work on Central Asia "In the Heart of a Continent," by a lament that his early education had been wasted on dead languages, so that he started on his travels ignorant of scientific methods of thought or observation (see NATURE, June 11, 1896). Dr. Sven Hedin has no such fault to find with his upbringing. Trained in physical geography in the University of Berlin under the great Asiatic traveller Baron von Richthofen, he chose the least-known parts of Asia as a field for exploration, and fitted himself as an explorer by years of preliminary study and Eastern travel. Few men, especially in this country, attracted instinctively to the studies which can make them geographers, have had the opportunity of becoming travellers, although many travellers have been stimulated by their experiences to take up the study of geography. Dr. Hedin writes, as he travelled, like an accomplished geographer. He was no sportsman; and, although a sedulous collector, he was neither botanist, zoologist nor geologist, possessing only that sympathetic general knowledge of natural science which is essential to a geographer, and invaluable to a traveller as a guide to observation. He not only qualified himself in practical astronomy and surveying, so as to collect trustworthy material for maps, but took special pains to master all necessary languages. Besides his native Swedish he was proficient in German, French, Russian and English, and could thus converse easily with every European traveller and official he met; he had already learned Turki, so that in western Central Asia he could question the natives directly, and in the course of the journey he acquired sufficient facility in the use of Mongol and Chinese to enable him to dispense with interpreters.

Being a translation, though a good one, "Through Asia" cannot be compared in style with the best English books of travel; but in substance it is so full, solid and interesting that this is soon forgotten. An awkward phrase, indeed, puzzles one occasionally, such as "diopters" (which may mean the sights for a plane-table); "temporal observations," instead of "observations for time"; and a few others. The word "glen" is very frequently used in a sense which appears to be the same as valley, but may contain some undesignated shade of difference.

King Oscar, whose interest in travel and in all matters Oriental is well known, interested himself in the proposed journey, and assisted in supplying the very modest funds (1900*l*.) required for what has turned out to be one of the cheapest, as well as one of the best, of the great journeys of the century.

Dr. Hedin travelled altogether 14,600 miles, of which 2020 had never before been traversed by a European. He made a continuous map of his route for 6520 miles, which is now being worked up in the great cartographical establishment of Perthes in Gotha, and innumerable observations on the volume of rivers, the depths of lakes and the temperature of air, water and soil, which will all be discussed and published separately. His collections of natural history specimens and archaeological remains will also be made the subject of monographs. Thus although the mass of the scientific data obtained is large, but little of it is considered in this book, which is a compressed narrative of the whole three years' journey, containing, indeed, a fair amount of adventure quietly told, and just enough of the more technical aspect of geography to enable the general reader to understand the explorer's motives and appreciate his results. Enough is stated, however, to show that it is the record of one of the finest scientific journeys ever carried out in trackless Asia.

[1] "Through Asia," by Sven Hedin. With nearly three hundred illustrations from sketches and photographs by the author. Two vols. Pp. xx + 1278. (London: Methuen and Co., 1898.)

Dr. Hedin's work was divided into several expeditions, between which he rested for a few months at a time at Kashgar and other Asiatic cities. The first journey, after driving across the Kirghiz steppe round the north of Lake Aral to Tashkent, was the crossing of the Pamirs in the winter of 1893 by a road traversed in the open season by the Russian garrison of Fort Pamir, and kept open for their mails all the year. The most interesting incident of this journey was the sounding of the great Kara Kul by means of holes cut in the ice. The lake is without outlet and salt, with an area approaching 150 square miles, and the elevation of its surface above sea-level is 13,000 feet; it is completely surrounded by lofty mountains. The lake is divided by a low peninsula into two basins; the eastern, in which three soundings were made, varied from 41 to 63 feet in depth, with a temperature of from $34^{\circ}\cdot2$ to $35^{\circ}\cdot2$ at the bottom, and the ice was from 3 feet to 3 feet 6 inches thick. The western basin was tested by four soundings, of which the shallowest was 256 feet with a bottom temperature of $35^{\circ}\cdot8$, and the deepest 756 feet with a bottom temperature of $38^{\circ}\cdot3$. The thickness of the ice here was only from 1 foot 4 inches to 1 foot 9 inches; and the temperature of the air was -20° F. at night. The depth, although considerable, should hardly, however, be called "abysmal," even for a lake.

The second piece of work undertaken was the study of the great snow-clad mountain Mustagh-ata, which is the loftiest summit of the Pamirs, towering to 25,600 feet. Dr. Hedin ascended its slopes to the height of 20,660 feet, where he passed the night. To this elevation he was able to ride on a yak, and bring up his whole camp equipment: so that a trained mountaineer to whom it is a pleasure to climb higher than other people, should here have a good opportunity for making a "record" climb from a comfortable base. Dr. Hedin, however, was not a mountaineer, and defeated in the attempt to climb, he made a careful study of the glaciers all round the mountain. The snow-field of Mustagh-ata measures roughly 10 miles by 6, and from the snow-line valleys radiate in all directions, many of them occupied by great glaciers, the streams from which are collected in rivers on the plain, which flow round the base of the mountain for three-quarters of its circumference before they turn finally to north and south. The work on Mustagh-ata occupied, with occasional intervals, the time from April to October 1894, and during much of this time Dr. Hedin lived amongst the Kirghiz as one of themselves, and obtained a great deal of information as to their customs and mode of life. The winter was spent in Kashgar, where Mr. and Mrs Littledale happened to be staying at the time, preparing for their great journey across Tibet from north to south.

In February 1895, Dr. Hedin set out on his most adventurous journey, in which he barely escaped with his life, in the desert of Takla-makan. Crossing the Yarkand-daria at 39° E., the desert was crossed in a more or less easterly direction. The party had eight camels, of which only one survived; and the guide with another man, who were believed to have treacherously taken a smaller supply of water than was ordered, perished of thirst in the sand, possibly through being unable to desert so soon as they had planned. Fifteen days were expected to suffice to reach the Khotan-daria, but twenty-six were required. During the greater part of this time the scenery was one monotonous waste of yellow sand dunes, the surface unvaried by a vestige of vegetation, or even by a stone. The largest dunes were as much as 200 feet in height with a crescentic ground plan, and exceedingly steep on the leeward slopes. It was impossible to follow a straight course, and as the intermediate low ground was often occupied by "pools" of the finest sand, in which the camels sunk deeply, it was often necessary to wind over the slopes, following the crests of successive dunes. No living thing was to be seen. When at last Hedin emerged from the sand, and struck the Khotan-daria, he was alone, on foot, and in rags. By carrying back a supply of water in his boots he saved one of his men; two others with one camel also escaped, and brought some of the instruments and all the note-books; so that what at one time appeared likely to be irretrievable disaster was averted, but narrowly, as he was a week without food. The river was followed northward to Aksu, and Kashgar re-entered on June 21. While waiting for the new instruments, which had been telegraphed for to Europe, Dr. Hedin took another run to the Pamirs, a sort of pleasure trip, for he had the good fortune to share in the festivities of the Anglo-Russian Boundary Commission.

In December 1895 he left Kashgar finally for further explorations in the desert, travelled to Khotan through Yarkand, and along the southern margin of the desert, and collected so much material that he proposes to make another book of it. The *kara-buran*, or black sandstorm, which is common in that region at certain seasons, seems to be similar to the American tornado. This type of storm occurs only in summer, and almost always in the afternoon, rarely lasts above an hour, comes more frequently from the west than from the east, and is so furious in its intensity as to sweep sheep away bodily. Another strip of the desert was crossed from the Khotan-daria to the Keriya-daria, a river never before visited by a European; and on the way Dr. Hedin discovered the ruins of an ancient city, called Takla-makan, built of wood, and full of relics of an ancient time, when the prevailing religion was Buddhism. The curious appearance of the ruins as they project from the sea of dunes is well brought out in the illustration on the next page. These dunes have a uniform angle of 33° with the horizon on the steep leeward slope, while the windward slope varies from 20° to as little as 1°; a calculation gave about 160 feet per annum as their average rate of advance. The grassy borders of the Keriya-daria were found inhabited by a race of shy shepherds, who rarely visit a town, and had never seen a European before. The desert margins abounded in wild camels, several of which were shot. From all Dr. Hedin could see and hear of them he was convinced that they are descendants of the tame camel, their present wild life being a reversion to nature, not a primitive state.

Proceeding northwards, the Tarim river was crossed on the ice in February; this river, in the latitude of Naples, is said to remain frozen for three months of the year, a good example of the effect of continental climate, although the atmosphere is too dry to furnish any snowfall.

The Lop-nor region was made the object of careful study, and geographically this is one of the most interesting parts of the whole book. A controversy as to the character of Lop-nor has been going on for many years. The great Russian explorer Przhevalsky explored a lake which he held to be the ancient Lop-nor; but it was fresh, yet without outlet, which proves that it must be of very recent formation. Richthofen pointed out that the ancient Lop-nor, placed by Chinese geographers a degree further north, must be salt if it still exists; but Hedin discovered that there is a very recent lake which he believes reoccupies the western part of the bed of the old Lop-nor, which has been nearly filled up by desert sand. The whole region is almost at the same level, and the lakes are so thickly overgrown with huge reeds, that it is very difficult to trace the boundaries of the shallow sheets of water, which evidently shift in position from time to time as the rivers of the desert also do. The Lop-men are very expert canoists; but the translation is obviously in error in speaking of them as "rowing" the long narrow canoes with "oars," which would be impossible without outriggers; the illustrations show them paddling by means of paddles, a very different method of propulsion.

The last piece of exploration recorded in the book has

redeemed a long strip of the map of Tibet along the parallel of 36° N. from absolute blankness. Leaving Khotan with a large caravan of horses, donkeys and camels in June 1896, Dr. Hedin proceeded eastward, skirting the desert to Kopa, then turning south-west into unknown country across the west end of the Altyn-tagh, he crossed the parallel range of the Arka-tagh (close to the place where Littledale crossed it going south), and marched eastward for twenty-six days along a great elevated region averaging nearly 16,000 feet in height, with the Arka-tagh bordering it to the north, and another snowy range, the Kokoshili, to the south. This is spoken of as a "latitudinal valley," or as a valley bordered by "latitudinal mountain ranges," but the sense of the term is not clear, the expression *longitudinal valley* would appear to be the correct one, as it seems to be a vast trough between parallel mountain ridges. The centre of the trough is occupied by a succession of small basins, each an independent centre of drainage, and each containing a long narrow salt lake lying east and west. It is really a land-surface in the making. If the precipitation had been heavy enough to fill these basins and start rivers flowing from one to another, the whole valley would now be drained by a great axial river; but in default of river erosion the basins remain untapped, and wind and frost alone are fashioning their peculiar topography. A little yellow grass was found in patches in the basins, on which vast herds of wild asses and wild yaks were feeding; but for fifty-five days no human being or human habitation was seen. We look forward with much interest to the detailed description of this interesting region, the map of which, prepared in Sweden, is obviously only provisional, and not accurate; for instance, the distance between camps xxii. and xxiii., said in the text to be the longest day's journey, is represented as very nearly the shortest, and the position assigned to the camps does not fit the description. At length, on October 1, 1896, Mongols were met, and a descent made from the Tibet plateau to the Tsaidam swamps, whence the route lay over known ground to Peking, and thence Dr. Hedin returned to Sweden across Mongolia, Siberia and Russia.

When one contemplates such a journey, so brightly and popularly told, full of adventure, hardships and solitude, yet every hour of it occupied in collecting, observing, note-taking and map-making, and when one remembers that only German training can make such work possible at present, even to the most adventurous and persevering traveller, it is impossible not to be struck from another side by Sir John Murray's feeling, expressed in his recent appeal for Antarctic exploration:—

FIG. 1.—The ruins of Takla-makan east of the Keriya-daria.

"The conviction that we are, in exploration and scientific research, not doing anything like our best, is much deepened when we compare our present efforts with what is being done in these directions by other progressive nations." HUGH ROBERT MILL.

THE AMERICAN AGRICULTURAL YEAR-BOOK.[1]

YEAR by year the official volume issued by the Department of Agriculture at Washington appears to increase in interest and importance, and the latest addition to the series is well-nigh bewildering in the

[1] "Year-book of the United States Department of Agriculture, 1897." Pp. 492; with 40 plain or coloured plates, and 45 figures in the text. (Washington: Government Printing Office, 1898.)

scope and variety of its contents. Making every allowance for the fact that the functions of the United States Minister of Agriculture extend over an area practically as large as that of Europe, and for the circumstance that much of the agricultural practice of the western hemisphere is still in the tentative stage, the volume is nevertheless impressive on account of its encyclopaedic character. Precedence is given to the annual report of the Secretary, who is the political head of the Department, his position being comparable with that of the President of the Board of Agriculture in Great Britain. This document, of which a preliminary issue was made at the close of last year, occupies 50 pages, and deals comprehensively with the whole work of the Department. A section of 220 pages is next taken up by articles, nineteen in number, written by the heads of the several divisions of the Department, and setting forth the relation of the work of each division to the farming industry. This, we may remark, is a special feature of the current volume, and is the outcome of an express wish on the part of the Secretary, who took over the reins of office for the first time last year. The third section, extending to 340 pages, is one with which readers of the Year-book are familiar, as it has been a feature of previous volumes.

FIG. 1.

It consists, on this occasion, of a series of papers by acknowledged authorities on such subjects as the fruit ndustry, birds that injure grain, lawns and lawn-making, utilisation of hybrids in plant-breeding, soil problems, seed testing, leguminous forage crops, danger of importing insect pests, and the utilisation of by-products of the dairy. An appendix of 140 pages is well filled with a variety of useful matter, mainly statistical; but we do not observe at p. 714, where the area under wheat in 1897 is given as 39,465,066 acres, any reference to the fact that this represents a deviation of nearly 5,000,000 acres form the true extent of surface thus occupied, the under-estimate being apparently the result of an accumulation of errors for a series of years. Lastly, the volume is furnished with an admirable index of 32 pages, which adds greatly to its value as a work of reference.

A few examples, selected at hazard from different parts of the year-book, will serve to indicate the nature and value of the information which it conveys. Attention has been bestowed upon the investigation of certain crops, the produce of which is largely imported, but which could probably be grown with profit in the United States. Chicory is a case in point; the whole of this material required for consumption has hitherto been imported, but it is believed that in the course of ten years the country will be growing enough to entirely meet the hom[e] demand. Ten years ago the United States importe[d] annually about 130,000 dollars' worth of insect powde[r], but the experimental cultivation of pyrethrum in Cal[i]fornia proved a success, the result being that the impo[rt] trade referred to has dwindled away. The loss in th[e] United States from the diseases affecting cereal crops [is] estimated to amount to 25,000,000 dollars or 30,000,00[0] dollars annually. Cotton, tobacco, potatoes and oth[er] staple crops are correspondingly damaged. In one yea[r] the loss arising from diseases of orange, lemon and othe[r] citrus fruits was estimated at more than 450,000 dolla[rs] in Florida alone. From plant-diseases of all kinds th[e] loss to the entire country is put at 150,000,000 dollars t[o] 200,000,000 dollars annually. Against such calamitie[s] the work in the division of vegetable pathology is makin[g] steady progress, and significant examples are given o[f] the benefit that has thus already accrued to the grape grower, the nurseryman and the orchardist. Th[e] diversification of crops is advocated as a check upo[n] "the marked geographic concentration of agricultura[l] productions," which has resulted in twenty-five States, o[r] just half the total number, producing 98 per cent. of th[e] cotton, 95 per cent. of the maize, 95 per cent. of th[e] barley, 93 per cent. of the oats, an[d] from 80 to 90 per cent. of the wheat[,] rye, buckwheat, tobacco, potatoes an[d] hay grown in the entire countr[y]. Soils are being studied with a thoroughness that is probably unparalleled. The classification of soils o[n] a geological basis, their texture, thei[r] structure, and their relation to water are receiving the fullest attentio[n]. With regard to the cause of the movement of water in soils, "it was understood that it was the contractile powe[r] of the film of water around the soi[l] grains that caused the movement o[f] water to the plant. It appears now from a minute study of this problem that the movement is dependent upon the curvature of this film rather than upon the total area of its surface." Many an English traveller on the western prairies has been struck by the seemingly harsh and innutritious herbage upon which cattle and horses nevertheless live and thrive. A discussion of the value as forage of so-called weeds permits a reference to various plants which are drought-resisting, or thrive on alkali lands, and are valuable as forage. They include white sage (*Artemisia* spp.), green sage (*Bigelovia* spp.), sweet sage or winter fat (*Eurotia lanata*), salt sage (*Atriplex* spp.), and grease wood (*Sarcobatus vermiculatus*). It is probable that these could be profitably grown under cultivation, and thus made to yield a much larger amount of forage than is now obtained. The contention that every farm is an experiment station cannot be controverted, and it would be advantageous to farmers in all countries were they more habituated to the regular use of the note-book. The cultivation of catch crops to maintain a supply of nitrogen in the soil, is a headline that cannot fail to attract the eye of English agriculturists. If catch-cropping is understood and intelligently practised anywhere, it is on the light arable lands of England, where the system may almost be said to have originated —at a time, moreover, when practice was in advance of science, for farmers had approved and adopted the system before the extension of our knowledge of the nitrogen problem had supplied the theoretical justification. The work of the chemical division with regard to the development of cane and beet, and other sugar-producing crops,

has been fruitful in result. In the course of experimental work occupying eight years, the percentage of sugar in field crops of sorghum was raised from 9 to 14. The investigations concerned with beet cultivation have been so successful that the establishment of an indigenous sugar industry is now certain, and the benefit to American agriculture in the near future will be measured by hundreds of millions of dollars.

It would be instructive to refer to the work of the Weather Bureau, and of the divisions of entomology, agrostology and forestry; but it must suffice to conclude with a few observations on the bureau of animal industry.

Those who have been engaged in recent years in the administration of the Diseases of Animals Acts in Great Britain will best appreciate the comprehensiveness and the excellence of the work of the Washington Bureau. It is a bold statement to make, perhaps, that the whole of the United States territory—from the Atlantic to the Pacific, and from the great lakes to the Gulf of Mexico—has been swept free from pleuro-pneumonia; and those who are familiar with the history of this most troublesome disease in Great Britain will only hope that the assertion may prove to be true.

The microscopic inspection of pork intended for export is worthy of all praise, and we reproduce an illustration showing this work in progress. Last year 1,881,309 specimens were thus examined for trichinae, and only 13,325 were found infested; the cost of this inspection was 111,670 dollars.

EDWIN DUNKIN, F.R.S.

At the ripe age of seventy-seven, with the consciousness of having fulfilled a useful career, and amid the respect and sympathy of his associates, Mr. Edwin Dunkin has passed away, again diminishing the small band of zealous assistants, that Sir George Airy collected around himself, when some sixty years ago he undertook the reorganisation of the Royal Observatory, and inaugurated that system of uniform and continual observation which has ever since remained the chief characteristic of that institution. To trace the career of Mr. Edwin Dunkin is to recall the history of the Observatory under its late director, for during nearly half a century Mr. Dunkin took a prominent part in its activity, filling many responsible positions, till finally he became the chief and confidential assistant. In whatever capacity he was placed he was admirably adapted to it by reason of his painstaking and accurate observation, his loyalty to his chief, and his keen interest in the science. It was his fortune to see and to assist in the creation and development of a magnetical and meteorological department, to witness the establishment of a system of extra meridional observations of the moon, to see the observations of Right Ascension and Zenith Distance effected by a single instrument, and to mark the substitution of chronographic registrations for the older method of recording transits. He remained at his post long enough to note the introduction of the spectroscope and of photographic processes: in a word, to form a link between the methods of the old astronomy of position and the purposes of the newer physical science. He lived to see the staff of the Observatory trebled and quadrupled, as fresh objects of inquiry were brought within its scope; and that he could adapt himself to every change, and lend his experience to ensure the smooth working of the ever-growing machinery, is to say that he was an able and useful official, rendering good work in his day and generation.

Naturally, from his official position, Mr. Dunkin took part in many of the scientific expeditions organised at the Royal Observatory under Government auspices. Among the earliest of these was a visit to Christiania to observe the total eclipse of the sun in 1852. The instrumental equipment provided, consisted of a telescope of $3\frac{1}{2}$ inches aperture, mounted on a firm tripod, and provided with steadying rods. If this optical assistance appears to us now antiquated and inadequate, the observations made with it read even more strangely. We may quote one sentence from the official report, which illustrates the progress of physical inquiry accomplished within a single scientific life. Mr. Dunkin is describing his first impressions of a solar prominence:

"My eye was intently fixed upon it for about a minute of time, and during that interval not the slightest change took place in its form. Its colour was pink, or rose colour, but the shade was not very deep. It seemed to me at the time, from the excessive steadiness of this prominence, and from the fact that I had zealously watched it for so long an interval without its undergoing any change, that this object had some connection with the *moon*. However . . . it is possible I may be deceived."

Another classical experiment in which he was engaged, and to whose minute care the measure of success obtained was mainly due, had reference to the determination of gravity at different distances below the earth's surface, by means of pendulum experiments. Some thirty years previously, the late Astronomer Royal had carried out an investigation of the same nature, which had not led to a satisfactory termination; but in the case of the Harton Colliery, where experiments could be effectively made at a depth of 1260 feet, Sir George Airy expressed himself as quite satisfied with the result achieved, and considered that it established a favourable precedent for similar inquiries in the future. The result was to show an increase in the force of gravity of 1/19000 at the depth reached. Longitude determinations may be said to come almost within the daily routine of the Royal Observatory, and it would not be necessary to refer to the share Mr. Dunkin took in these, but for the fact that the system of telegraphic signals was a new and practically an untried method when Mr. Dunkin and M. Faye were engaged in the longitude determination of Paris. Doubtless there were difficulties in those days, which have been so effectually overcome that they have been forgotten; but as a pioneer, Mr. Dunkin, and those who were associated with him, must have exhibited a manipulative skill which we may now fail to appreciate.

We should do less than justice to Mr. Dunkin's memory if we did not recall his long and eminent services to the Royal Astronomical Society, which he served in various capacities. He was Secretary at the time of the removal of the Society's property from Somerset House to its present quarters, and the reorganisation of the library, and the restoration of order into the Society's affairs, which had fallen a little out of gear, devolved mainly upon him, but his methodical habits and unstinted devotion to the interests of the Society ensured complete success in the regularity and management. Among other services to the Society, one may mention the many obituary notices which it was his misfortune to have to write, but which were always recognised as just and appreciative, and not without literary merit. His scientific communications had generally some reference to points of importance in practical astronomy, such as the treatment of personal equation in observations, or the determination of proper motions of stars. He was eminently a practical astronomer, rendering useful, if less brilliant work than the mathematician; but the many solitary hours he passed at the eye-piece of the transit circle, or the altazimuth, will not be without their due effect in advancing the interests of astronomical science.

W. E. P.

NOTES.

WE are informed that the Government is prepared to make the financial arrangements necessary to enable the Imperial Institute to become the headquarters of the Organisation of the New University of London. This decision of the Government was brought before the Senate at its meeting yesterday by the Vice-Chancellor, and it is hoped that no unnecessary delay will occur in securing the agreement of all parties concerned. While it is doubtful whether a Faculty of Commerce commensurate with the other Faculties can be at once established, it is most important that the various subjects which would naturally be included in it should be taught. This teaching might fairly find a place in the Imperial Institute under the authority and control of the New University. Some of the instruction would be germane to the valuable collections of raw materials, &c., in the Institute.

A VERY considerable discussion of an informal character is now going on among many interested in the various institutions which may form part of the new University. It is to be deplored that there is a great probability of the work of the Commission being hampered by the fact that many of the suggestions now being made are more inspired by the local interests concerned than by the desire to help on the educational question in the abstract. We use the word abstract in no pedantic sense, and with a full appreciation of the concrete questions involved. The Commission has to deal with an area defined by a radius of thirty miles, a population which we may roughly estimate at seven millions, and a large number of existing institutions. The amount of good the Commission will ultimately produce along new lines will, we take it, be capable of measurement by the success it will achieve in coordinating the old forces which are already at work, by working on the principle of organic growth and regarding what exists from the most general standpoint. It is from this point of view that we deprecate some of the suggestions now being made, because, if accepted, they will harm existing institutions, because the new University must not commence by localising itself, however high any local bid may be, and because again no good work will be achieved if any new suggestions be accepted before the actual condition is fairly grappled with, mastered and legislated for.

THE President and Council of the Geological Society will be "at home" to the Fellows on Friday, December 16.

THE *Pioneer Mail* states that the Nizam's Government has sanctioned the immediate construction of a complete and thoroughly equipped Pasteur Institute for Hyderabad. It will adjoin the hospital and medical school, and will be available in about six months for patients.

IN the forthcoming session of Congress, the Hurley Bill, providing for the adoption of the metric system of weights and measures in the United States and its compulsory use in all Government transactions except the completion of surveys of the public lands, will be again brought up. The Bill was defeated by only three votes in the fifty-fourth Congress, and the increased interest since given to the subject will, it is hoped, lead to the adoption of the measure.

A FEW particulars with reference to the discovery of a new system of incandescent electric light, by Prof. Nernst, of Göttingen, are given in *Science*. The light requires neither vacuum nor tender filaments. The essential point of the invention is that when magnesia is heated above 3000° C (a temperature far above the melting point of platinum), it becomes a good conductor, and a very weak current is sufficient to keep it in an intensely luminous condition. Either direct or alternating currents may be employed, and the magnesia is little injured by use. The preliminary heating Prof. Nernst accomplishes by placing the magnesia in the focus of a reflector. On the inner side of the reflector is a spiral wire of platinum, which when brought to incandescence by a current, produces heat sufficient to render the magnesia a conductor; a current is then passed directly through the oxide by the wire, and that in the spiral is shut off. As advantages over the ordinary incandescent lamps Prof. Nernst claims that the same amount of light can be furnished at one-third the cost, and as the magnesia allows of being heated to a much higher degree than a carbon filament a purer light is obtained. The successful employment of a cheaper substitute for the platinum is also announced, though the name is not made public.

PROF. GEORGE FORBES, F.R.S., referred to the utilisation of the Nile cataracts, in his recent lecture at the Society of Arts on long distance transmission of electric power. He remarked as follows:—"My report on this subject is in the hands of the Egyptian Government, and is their property; but I am not divulging secrets when I tell you that the electric lighting of Cairo could be done cheaper by power generated at the First Cataract than by steam engines at Cairo. The distance is 400 miles as the crow flies. Do not imagine that I propose lighting Cairo immediately in this way. The Government has far more important uses for the power, not only in the irrigation of the country as it is, but still more for the perennial irrigation which will be so much extended when the great reservoir designed by Mr. Willcocks, Sir William Garstin, and Sir Benjamin Baker shall be completed by Mr. John Aird. You may take it as certain that before long the cataracts will be harnessed and forced to assist in developing not only Egypt proper but the Sudan, and especially the Dongola province up to the Fourth Cataract, which, with efficient irrigation, may become the most fertile country in the world."

AFTER several visits to the Orkneys, Prof. Newton succeeded this summer in landing upon the Holm of Papa Westray, a small island lying to the eastward of the larger one, from which it is separated by a comparatively narrow and shallow sound. A survey of Papa Westray in 1888 led Mr. Buckley to believe that he had found the last breeding place—reputed to be thereon—of the Great Auk or Garefowl (*Alca impennis*). The unsuitableness of any part of the island as a breeding place for such a bird was afterwards pointed out; but an examination of the Holm of Papa Westray led to the discovery of a locality adapted in every way to the habits of the Garefowl, and Prof. Newton considers that there is no room for doubt that the Holm was the true home of the species whose extirpation, so far as Orkney is concerned, was compassed in 1813. In connection with this subject it is interesting to mention that Mr. Symington Grieve contributes to the *Transactions* of the Edinburgh Field Naturalists' and Microscopical Society some additional notes on the Garefowl, with special reference to two newly-recorded skins. He states that the existing remains may now be summarised as follows:—Skins, 80-82; skeletons, more or less complete, 23-24; detached bones, 862-874; physiological preparations, 2-3; eggs, 71-72.

THE weather reports issued by the Meteorological Office show that during the month of November the rainfall in different localities has been considerably influenced by the tracks of the storms, some of which have passed to the north and others to the south. Generally speaking, the rainfall has been excessive in the north-west and south-west of our islands, and deficient in the eastern parts. But not unfrequently stations not very far apart have received very different amounts of rainfall. At

Stornoway (Hebrides) the fall was about double the average, the excess being 5 inches; while at Sumburgh Head (Shetlands) there was a deficiency of 0·27 inch. At North Shields there was an excess of 0·95 inch above the mean for the month, while at Leith there was a small deficiency. The following values above or below the monthly mean are noteworthy:—Valencia, + 1·26 inch; Roches Point, − 0·96 inch; Hurst Castle, + 1·25 inch; Dungeness, − 1·83 inch; Holyhead, + 0·08 inch; and Liverpool, − 1·12 inch. Generally speaking, the rainfall since the beginning of the year is still considerably deficient, except in the north of Scotland, where the excess is above 9 inches.

AT the meeting of the French Meteorological Society on November 3, under the presidency of M. Poincaré, M. Teisserenc de Bort presented the first part of a very important work by Dr. Hildebrandsson and himself, entitled "Les bases de la météorologie dynamique. Historique, état de nos connaissances." This part contains the history of all the ancient researches from the time of Aristotle to the present date. In the second part, now in the press, the history will be continued, and will be followed by theoretical questions, such as the distribution of aqueous vapour in the atmosphere, and that of the meteorological elements over the surface of the globe. A paper by M. Coeur de Vache was read on the atmospheric electricity of the months of March 1886–1895, or during a period of 213 days. This investigation shows that the diurnal oscillation of atmospheric electricity depends especially upon the humidity of the air, both with regard to its amplitude and to the normal hourly values. The other papers read related to the unmanned balloon ascents of October 3 last, by M. Teisserenc de Bort, and to the action of the moon on the movements of the atmosphere, by M. Poincaré.

WE have received a copy of "Observations and Researches" made at the Hong Kong Observatory during the year 1897, under the superintendence of Dr. W. Doberck, the director. In addition to the usual observations and results of the meteorological and magnetic instruments, the report contains detailed information upon the other valuable work carried on at the observatory. For the daily weather forecasts a complete success of 65 per cent., and a partial success of 31 per cent., are claimed. Following the method used in some other meteorological establishments, and adding together the sum of total and partial success, the high figure of 96 per cent. is obtained. During the year 1897, besides the meteorological registers kept at forty stations on shore, the log-books of 283 vessels have been copied, for use in the construction of trustworthy pilot charts of the Eastern seas. The report also contains the third edition of the law of storms in the Far East, to which we briefly alluded in our issue of October 20. Dr. Doberck is very sanguine about the results of this investigation, and states that the typhoons, about which little was known when the observatory was built, in 1883, are now among the best understood atmospheric disturbances. A chart is given showing the average tracks of these storms.

THE question of the porosity of thin steel plates under heavy hydraulic pressure having been raised (says *Engineering*), experiments have been carried out at the Washington Navy Yard with the view of settling the point in a practical way. Pieces of sheet steel of ¼ inch, ⅛ inch, $\frac{1}{16}$ inch, and $\frac{1}{32}$ inch in thickness were subjected to a water pressure of 6000 lb. per square inch, and in no case was any percolation found. A ⅝ inch rivet joining two ⅛-inch plates also proved tight under the same pressure. A test was also made to determine the friction of water under high pressure, and, while it was inconclusive, there was no evidence that the friction of water under high pressure was any greater than the friction of water not under pressure.

AMONG the methods of reducing a compressed gas to a lower pressure by irreversible transformations, those of Joule's well-known experiment of expansion into a vacuum, and Lord Kelvin's experiment of expansion through a porous plug are the most important, and the recent applications of the Kelvin effect to the liquefaction of gases has added fresh interest to the latter. An investigation of the thermodynamics of the process in question is given by M. A. Witkowski in the *Bulletin* of the Cracow Academy, pp. 282–295. These observations support the view that beyond certain limits of temperature and pressure, expansion of a gas is accompanied by heating instead of cooling, and the author investigates the temperature of reversal for air and for hydrogen. The conclusions tend to show that in liquefying gases by expansion there is no advantage in making the initial pressure too great; a pressure of 200 atmospheres, as employed in Linde's machine, being amply sufficient. The cooling resulting from expansion into a vacuum is rather greater than would be obtained for the same pressures in the Kelvin-Joule apparatus.

THE study of hydrodynamics has been greatly facilitated by the series of reports which have been from time to time brought out dealing with the progress made in the subject during various periods. These include Sir G. G. Stokes' report to the British Association of 1846, Prof. Hicks' reports of 1881–82, Mr. Love's paper on Vortex Motion in the *Mathematische Annalen* for 1887, Prof. Hicks' account of the same subject in his sectional address to the British Association at Ipswich in 1895, and Prof. Darwin's Encyclopaedia article of 1888, on Tides. In *Science* for November 11, Prof. Ernest W. Brown, F.R.S., gives an interesting account of recent progress towards the solution of problems in hydrodynamics which have not been included in these previous reports. The author deals at considerable length with wave motion, viscosity, and two-dimensional discontinuous motion, pointing out that no case or three-dimensional discontinuous motion has been solved. In connection with viscosity Prof. Brown remarks that "in all problems hitherto solved, only the first powers of the velocities are taken into consideration." But a paper was published by Mr. Whitehead, in the *Quarterly Journal of Mathematics* (vol. xxiii. p. 78), dealing with second approximations to viscous motion, notably for the fluid surrounding a rotating sphere; and the conclusions arrived at seem rather to cast doubts on the validity of the ordinary first approximations. As Mr. Whitehead's paper seems little known, the present reference may save some mathematician the trouble of solving the same problem (as did the writer of the present note), and then finding that he has been anticipated.

A RECENT number of the *Revue Scientifique* contains the continuation of an article by M. P. L. Simond on the transmission of plague-virus. It is now well recognised that rats not only herald the advent of plague, but are themselves largely responsible as direct disseminators of the morbific material; but, as M. Simond points out, they do not account for all the subtle means by which the virus finds its way to the human subject. Further careful researches now show that parasites in the shape of fleas are extremely dangerous disseminators of plague-bacilli. Suspicion fell on these vermin, inasmuch as it is far easier to infect an animal with plague by subcutaneous inoculation than it is through the alimentary canal. A large number of experiments have been carried out by M. Simond to test the validity of his hypothesis, and just as Yersin showed that flies could transmit virulent plague-bacilli, so Simond has found that fleas taken from plague-stricken rats can communicate the disease to healthy animals, vermin from such sources containing in their excreta the virulent plague microbes. We have long known that dirt and plague go hand in hand, and M. Simond's instructive researches furnish yet another proof of the cardinal

importance of combating the disease by unremitting attention to sanitary conditions.

Mr. C. S. Stanford Webster calls attention, in the *Chemical News*, to a novel production of vortex motion. He states that when the freshly gathered leaves of the native Eucalyptus tree (*Eucalyptus globulus*) are ignited, they project vortex rings in considerable numbers in succession, accompanied by a spluttering noise. The best results are obtained by holding the scythe-shaped leaf vertically and igniting the apex—this being the part where the greatest number of translations are obtained. Mr. Webster thinks that possibly in the production of these vortex rings, blisters are first formed by the extrusion of the cuticular tissues, and, on the blisters bursting, air or aqueous vapour is spontaneously liberated, the rings being rendered visible on their contact with the smoke from the burning external portion of the leaf. The leaves of the small English variety of Eucalyptus possess similar properties to the native product, but in a lesser degree, the rings projected being insignificant in size, comparatively speaking.

We have received a letter from Mr. Charles W. Purnell, of Canterbury, New Zealand, criticising two of the statements made by Prof. Lloyd Morgan in his notice of Prof. Thorndike's experimental study of animal intelligence (Nature, July 14). Prof. Purnell sees no reason for denying to animals either "conscious [*i.e.* volitional or purposive] imitation," or "memory as involving true localisation in time and space." The facts adduced by Mr. Purnell, however, are not likely to be denied by Prof. Lloyd Morgan or by any careful observer of animal behaviour. The questions he raises seem entirely to turn on the definition of terms, for a discussion of which we cannot afford space.

The anthropological part of the *Journal* of the Asiatic Society of Bengal (vol. lxvii.) contains six papers, all of value. The taboo of names amongst the Santals is examined most carefully by Mr. P. O. Bodding, and his explanation of it seems convincing. Taking it in conjunction with other taboos, it seems to be a series of rules for defining and keeping intact the standard of conduct among the members of the tribal family, and it is well to note the scarcely veiled system of polyandry which obtains with regard to the wife of the family chief and his brothers. If this is the survival of an older social stratum, while the taboo existing between the family chief and the wives of his younger brothers marks the rise of a newer order of things, it seems that we have here a most interesting phase of social evolution. The Santals are divided into twelve totemistic septs, and Mr. Bodding also examines the taboos connected with this cult; and in another paper the same author deals with the salutations used by the Santals in a manner to show their bearing upon tribal society. The rain ceremony from the district of Murshidabad, Bengal, by Mr. C. C. Mitra, is highly instructive, especially as the author shows its close connection with Lithuanian and other European customs of modern times. By the same author is a paper on the lizard in Indian superstition and folk-lore. Mr. E. A. Gait's paper on human sacrifice in ancient Assam is a useful description of this practice according to the tribes among whom it obtains.

The *Bulletin* (vol. ii. No. 2) of the Madras Government Museum, by Mr. Edgar Thurston, shows how useful has been the work begun by Mr. Risley. The physical measurement and other particulars of the Eurasians of Madras and Malabar, accompanied by excellent photographs, are taken from a sufficient number of persons to be sure that normal results have been obtained, and there is an additional note on tattooing, with illustrations.

Mr. Henry Frowde, Oxford University Press, announces the forthcoming publication of a monograph on "The Micro-organism of Faulty Rum," by Prof. V. H. Veley, F.R.S., and Lilian J. Veley (*née* Gould). This micro-organism, which is said to have caused damage to the extent of many thousands of pounds, has only recently been isolated.

Prof. Wilhelm Wundt's "Grundriss der Psychologie" (Leipzig: Engelmann. London: Williams and Norgate) has reached a third edition. The original work, noticed in Nature, vol. liii. p. 604, 1896, has been revised and slightly enlarged. —Mr. Engelmann has also just published a second enlarged edition of Prof. Karl Eckstein's "Repetitorium der Zoologie." The work has been completely revised, and many additions have been made in the various sections.

A second edition of the late Carl Reutti's "Übersicht der Lepidopteren-Fauna des Grossherzogtums Baden" has been published by the Gebrüder Borntraeger, Berlin. The new edition has been prepared by Dr. A. Spuler, who was commissioned by the Karlsruhe Naturwissenschaftlich Verein and Herr Adolf Meess to undertake the work.—MM. Gauthier-Villars, Paris, have published a second edition of M. de Fonvielle's "Ballons-Sondes," a little volume containing an account of the methods and results of experiments with free balloons sent up with recording meteorological instruments.

The different methods of recording the movements of seismographs form the subject of a brief, but useful, paper by Dr. Cancani in the last number of the *Bollettino* of the Italian Seismological Society (vol. iv. p. 73). Omitting the photographic method on account of its expense and neglect of details, there remain two others, in one of which the record is traced in ink flowing from counterpoised pens, and in the second on smoked paper by means of very fine threads of glass. Dr. Cancani has recently employed both methods at the Rocca di Papa Observatory, and decides without hesitation in favour of the latter, the diagrams being clearer and the friction of the pointers very much less.

Two remarkably cheap and good globes—one celestial and one terrestrial—published by Messrs. George Philip and Son, have been sent to us for notice. Each globe is 6 inches in diameter, and is mounted in a solid brass semi-meridian on a polished stand. The celestial globe has upon it all stars down to the fifth magnitude, printed in white upon a dark blue ground; and also some nebulae and star-clusters. The stars are considered to be viewed from a point outside the globe, and not, as is the case with celestial globes usually, from the inside. The globe may thus be regarded as a collection of star-maps mounted for convenience upon a sphere. The terrestrial globe is very clearly printed; it shows ocean currents, steamer routes, and other matters of geographical importance. Both globes will be of assistance to teachers of geography, but their educational value would have been increased had it been possible to include a horizon with each of them.

Messrs. Griffin and Sons, Ltd., wish attention drawn to the fact that they have recently removed from their old premises in Garrick Street, Covent Garden, to 20-26, Sardinia Street, Lincoln's Inn Fields, London, W.C., where buildings have been specially constructed for their work. The same firm has just published the eighth edition of their catalogue of electrical apparatus, a copy of which has been sent to us. Among the scientific instruments and appliances included in the list are several noteworthy things. It is pointed out that Wimshurst machines with ebonite plates have many advantages over the glass plate machines, not the least being that they are not so liable to breakages. In the section of the catalogue containing

apparatus for experiments in voltaic electricity we notice a useful school galvanometer, having several novel features, and constructed in such a way that it can be entirely dismounted so as to explain the method of construction before the students in a class. Great care appears to be taken in the manufacture of resistance coils, all of them being tested and adjusted to within one-hundredth per cent. or one per cent. (according to price) of their value. In the magnetic section an interesting instrument described is Lenard's bismuth spiral for measurements of magnetic fields. The principle upon which the instrument is based is the change of resistance that occurs in bismuth when in a magnetic field; the alteration of resistance affording a means of determining the number of lines of force in the field tested. Many other instruments mentioned in the list show that Messrs. Griffin keep in touch with recent advances and educational requirements.

The *Electrical Review* for November 25 contains an interesting account, with illustrations, of the electrolytic chlorate works at St. Michel in Savoy. Power is supplied by the river Arc, sixteen turbines, each keyed to a dynamo, being employed. The solution of potassium chloride is placed in insulated vats lined with lead, and having a capacity of 11,000 gallons. The anodes are of platinum-iridium, and the kathodes of iron-nickel alloy. The primary electrolytic action is, of course, the resolution of the potassium chloride into potassium and chlorine; the potassium, however, forms potassium hydrate, and liberates hydrogen at the kathode. The potassium hydrate so formed is now brought under the influence of the chlorine liberated at the anode; and as a sufficient current density is employed to keep the temperature above 45°, the action proceeds according to the equation $6KOH + 3Cl_2 = KClO_3 + 5KCl + 3H_2O$. The chlorate is easily separated from the more soluble chloride by crystallisation. The works at St. Michel, and another at Vallorbes, are said to produce together 1800 tons of chlorate per annum. The introduction of the electrolytic process has resulted in a considerable fall in the price of chlorates.

The additions to the Zoological Society's Gardens during the past week include a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, presented by Mr. A. D. Michael; a Mantell's Apteryx (*Apteryx mantelli*) from New Zealand, presented by Sir Walter Buller, K.C.M.G., F.R.S.; two Dwarf Chameleons (*Chamaeleon pumilus*) from South Africa, presented respectively by Mrs. Todd and Mrs. C. Faraday Maypee; a Black Ape (*Cynopithecus niger*) from the Celebes, an Osprey *Pandion haliaetus*) captured at sea, a Praslin Parrot (*Coracopsis barklyi*) from Praslin Island, a Bell's Cinixys (*Cinixys belliana*) from Tropical Africa; a Home's Cinixys (*Cinixys homeana*) from West Africa, three Painted Terrapins (*Chrysemys picta*), a Salt-water Terrapin (*Malacoclemmys terrapin*) frnm North America, three Reeve's Terrapins (*Damonia reevesi*), a Black-headed Terrapin (*Damonia reevesi unicolor*) from China, four Caspian Terrapins (*Clemmys caspica*) from Western Asia, a Japanese Terrapin (*Clemmys japonica*) from Japan, four European Pond-Tortoises (*Emys orbicularis*), European, a Ceylonese Terrapin (*Nicoria trijuga*) from India, two Blackish Sternotheres (*Sternothaerus derbianus*) from Madagascar, a Spix's Platemys (*Platemys spixi*) from Brazil, a Common Chameleon (*Chamaeleon vulgaris*) from North Africa, two Rufescent Snakes (*Leptodira hotamboeia*) from South Africa, deposited.

OUR ASTRONOMICAL COLUMN.

The New Comet Chase.—This comet seems to be brightening, and is now in a good position for observation. It is moving slowly towards the north-west, being situated now in the southern part of the constellation of Leo Minor, roughly in a prolongation of the line joining η and γ Leonis. The Centralstelle sends us a circular (No. 15), which informs us of the elements and a brief ephemeris computed by Coddington from observations made on November 23, 24 and 25. Another circular (No. 16), which has just come to hand, informs us of more accurate elements and ephemeris which have been computed by Herr. J. Müller from two Harvard photographs taken on November 14, and two Lick observations made on November 23 and 25. These are as follows:—

T = 1898 September 8·192 Berlin M.T.

$$\left.\begin{aligned} \omega &= 358^\circ\ 43'\cdot83 \\ \Omega &= 93\ \ 49\cdot05 \\ i &= 21\ \ 35\cdot35 \end{aligned}\right\}\ 1898\cdot0$$

$$\log q = 0\cdot33144$$

Ephemeris, Berlin Midnight.

1898.		R.A. h. m. s.		Decl. ° ′		Br.
Dec. 8	...	10 41 13	...	+25 3·2	...	1·4
,, 10	...	10 43 32	...	25 17·9	...	1·4
,, 12	...	10 45 45	...	25 33·3	...	1·4
,, 14	...	10 47 51	...	+25 49·3	...	1·4

The Nebula of Andromeda.—The variation in brightness of a portion of the nebula of Andromeda, as announced by Seraphimoff some weeks ago, does not seem to have been generally corroborated, and the observations of Prof. Barnard (*Astrophysical Journal* for November) do not suggest any variation. In June and July of the present year this observer made a series of measures of the nucleus with reference to two eleventh magnitude stars, one preceding and the other south, and during this time the nucleus was well seen, though not stellar. No trace of the Nova of 1885, although carefully looked for, could be observed. After Seraphimoff's announcement both the 40-inch and the 12-inch telescopes were turned on to the nebula, but "it was evident that no perceptible change had occurred in the nucleus or the nebula itself . . . and the impression has always been that the nebula is unchanged."

Not only this observer, but both Hartwig at Bamberg and Comas Sola at Catala (*Astr. Nach.* No. 3529), record no variation; the former from eye observations and the lattet from photographs taken before and after the announcement mentioned above.

The Planet Witt DQ.—In a previous number of Nature (November 3) we brought together much of the information that had been published concerning the interesting new planet discovered by Witt. The importance of this small planet, which at times approaches the sun nearer than Mars, necessitates that it should be closely watched, and its motion accurately determined. Needless to say, such observations are being carried out in many observatories, so that when a sufficiently large part of the orbit has been described we shall be presented with more accurate elements. The elements previously published by Berberich show now deviations from the true ones as gathered from the observed and calculated positions of the planet. Mr. H. N. Russell, of Princeton (the *Astronomical Journal*, Nos. 448–450), has formed some new normal places from a comparison of several observations, and the elements he has deduced differ somewhat from those previously published. Millosevich, in an interesting contribution to the *Rendiconti della R. Accademia dei Lincei* (vol. vii., series 5A), has also computed some new elements, so we give the following comparison:

	Berberich.	Russell.	Millosevich.
Epoch.	1898 Aug. 31·5. M.T. Berlin.	id.	id.
M	220° 14′ 3″·7	224° 33′ 12″·3	222° 23′ 28″·7
ω	178 28 26·2 (1898·0)	175 47 50·1 (1898·0)	170 1 20·8 (1898·0)
Ω	0 3 48 53·0 (1898·0)	303 20 20·3 (1898·0)	303 24 53·1 (1898·0)
i	311 6 57·1 (1898·0)	10 45 1·8 (1898·0)	10 45 18·1 (1898·0)
ϕ	13 13 3·8	12 55 13·6	12 49 5·4
μ	2010″·131	2003″·86	2015″·119
log a	0·164521	0·1654245	0·163804
Period	645 days.	646·75 days.	644·06 days.

Prof. Simon Newcomb, in the same number of the *Astronomical Journal*, refers to the future oppositions of this planet

for the determination of solar parallax. The next most favourable opposition will occur in 1900 in November and December, so he gives a rough ephemeris for this period of approach. As this table will probably be useful for reference, we reproduce it below:—

	α	δ	Δ
	h. m.		
1900 Nov. 15	1 56	+ 54·7	0·358
20	45	54·0	·346
25	38	52·7	·336
30	32	51·5	·328
Dec. 5	30	49·7	·322
10	32	48·2	·314
15	34	46·0	·309
20	42	43 9	·310
25	1 48	+ 41·3	0·308

In the northern hemisphere the position of the planet among the stars can be fixed from hour to hour both by the photographic telescope and the heliometer. "The combination of observations," as Prof. Newcomb remarks, "in the eastern and western hemispheres will then, it may be hoped, suffice for the best determination of the solar parallax yet made by direct measurement."

A NEW ALGOL VARIABLE.—Mr. Edwin F. Sawyer describes, in the *Astronomical Journal* (Nos. 448–450), the observations of a variable which he shows to be of the Algol type. The star in question is D.M. + 12° 3557, and has a period of 21h. 21m., the fluctuations in brightness being about half a magnitude, namely, from 7·0 to 7·5. The intervals of time from maximum to minimum and from minimum to maximum occupy individually two hours and a half. The table containing the observations, which Mr. Sawyer has made between September 15, 1895, and October 27 of this year, shows that the star was near its minimum on September 9 and 16, October 3, 10, 11, 12, 20 and 27. Combining these observations with others made at Potsdam, the epoch and period have been approximately determined as 1898 October 3, 13h. 1m. Greenwich mean time, and + od. 21h. 21m. E. respectively. It is not without interest to note that this star, which is No. 2510 of the *Potsdam Photometric Catalogue*, was observed once each by Kempf and Müller on September 24, 1888, as 7·74m., and on October 29, 1890, as 7·57m. On each of these occasions the variable was near a minimum; but as the observations agreed so well, the final value 7·66m. was entered in their catalogue. The magnitude given in the *Durchmusterung* was 7 0.

THE GEMINIDS.—So unfavourable was the weather for meteor observations during last month, that it is very doubtful whether the Leonids and Andromedes were observed at all in England. At the end of this week, December 10–12, there will be a well-known shower emanating from Gemini; but although furnishing us with thirty or forty meteors in an hour, it does not compare with the sometimes magnificent displays that have been set down to the other two meteor swarms above mentioned. The absence of the moon on this occasion should render observations favourable.

THE ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

ON Wednesday in last week, being St. Andrew's Day, the Anniversary Meeting of the Royal Society was held in their apartments at Burlington House. The Auditors of the Treasurer's accounts having read their report, and the Secretary having read the list of Fellows elected and deceased since the last anniversary, the President (Lord Lister) proceeded to deliver the anniversary address. After the first part, containing obituary notices of the deceased Fellows, it proceeded as follows:—

The business of the Society during the past year has been fully dealt with in the Report of the Council[1]; and I have little to add to that statement. On the death of Sylvester, it occurred to some admirers of his great mathematical genius that it would be well to create a permanent memorial of him in connection with the Society by founding a medal to be called after his name. The Council, though not disposed as a general rule to add to the numerous distinctions of that character already at their disposal, felt that this was an exceptional case, partly on the ground of Sylvester's great distinction, and partly because, while there are several specialised medals, there is none devoted to the supremely important subject of pure mathematics. They, therefore, expressed their grateful approval of the proposal; and I have now to announce that the fund raised for the purpose being closed, amounting to rather more than 880*l*., a clear capital of 800*l*., together with the dies, will shortly be transferred to the Society. The dies are being engraved after designs by Sir John Evans.

[1] This Report has not reached us.

The help given in this matter by our Treasurer is but a small sample of the multitude of services which he has rendered to the Society during the past twenty years, in addition to the discharge of his official duties. How well these have been performed they only can know who, like myself, have served with him in office. The debt which the Royal Society owes to Sir John Evans has been referred to by the Council in terms of high, though not exaggerated, eulogy. I cannot but add the expression of my personal sense of the deep, I had almost said the irreparable loss which the Society sustains by his retirement.

The question who should be recommended to your suffrages as his successor has engaged the anxious deliberation of the Council. As stated in the report, various considerations have weighed with them. But I feel confident that, as time passes, the wisdom of the decision arrived at will be universally recognised.

Sir George Hamilton has, I believe, done wisely in sending out to India a British Commission, containing a majority of scientific experts, to inquire into the subject of the Plague; and I am glad that so distinguished a Fellow of the Society as Prof. Fraser of Edinburgh has been able to accept the position of Chairman.

The recent sad occurrences at Vienna may suggest the fear that our countrymen engaged in this duty, will be subjected to grave danger. But the disease as it showed itself in Vienna, was of an entirely exceptional form; and if we consider how few of the medical men and nurses who have for a long time past been engaged in actual attendance on plague-stricken patients, have fallen victims to the disease, we may dismiss from our minds the idea of any serious risk to the commissioners.

Their chief duties will, I believe, be to sift and report upon the somewhat heterogeneous and scattered pieces of evidence already published by various observers as to the nature and modes of transmission of the complaint, and the best means of dealing with it. One of the subjects which will engage their attention will be the efficacy or otherwise of the preventive injections of Monsieur Haffkine. On this question our Fellows are likely to have an opportunity of judging for themselves; for Haffkine himself has agreed to come over to this country in May, a time of the year at which his services in India can best be spared, in order to bring his facts before us at one of the "meetings for discussion."

There is no subject in Biology of greater interest at the present time, whether in a scientific or practical point of view, than that of the "serum therapeutics" of infective diseases. According to a recent report, which bears throughout the characters of authenticity,[1] a great success in this direction has been lately achieved. Mr. Chamberlain, whose enlightened action regarding malaria and allied disorders in Africa, has been referred to in the Council's report, consulted the Royal Society about two years ago as to the possibility of devising some means of arresting the fearful ravages of rinderpest among the cattle in the southern parts of that continent. The stamping-out process by wholesale slaughter which, at great expense to the country, formerly proved effectual in England, could not be thought of in South Africa, whose vast regions are sparsely populated, while buffaloes and other animals beyond human control are able to contract and spread the disease. But could nothing be done by modern scientific methods? The subject appeared full of hope, because, as was shown long ago in this country by Burdon-Sanderson, rinderpest resembles small-pox in the fact that one attack, if recovered from, protects against a recurrence of the disease.

Mr. Chamberlain was fortunate in securing, with the consent of the German Government, the services of that distinguished bacteriologist, Prof. Koch. We rejoiced to read the reports of his masterly researches and of the brilliant results which he obtained, promising to effect all that could be desired. The

[1] *Vide* "Rinderpest in South Africa," by John Maberly. *The Lancet*, November 5, 1898.

process which he devised did indeed, as we are informed, save the lives of thousands of cattle. In course of time, however, it turned out that the immunity conferred by it was not sufficiently permanent, while it was attended with some other serious practical inconveniences. Hence it became necessary to seek for some more perfect method. This has been done by a German investigator, Dr. Kolle, who went out to continue Koch's work, acting in co-operation with one whom I am patriotic enough to be pleased to speak of as an Englishman, Dr. George Turner, the Government Health Officer of Cape Colony. Koch had early ascertained that the serum of an animal which had recovered from rinderpest, if injected under the skin of a healthy animal, conferred upon it complete though very transient immunity. This was the basis of the work of Kolle and Turner, who, after a long series of laborious investigations, have, it appears, at length attained their object by simultaneously injecting, at two distant parts of the animal's body, a little of the antitoxic serum, and a dose of the blood of a diseased animal, which, without the serum, would prove certainly fatal. The result is that the beast becomes affected with the disease in a form so greatly modified that it causes as a rule, only slight symptoms, and sometimes none at all; and, though it occasionally proves fatal, it does so in considerably less than 1 per cent. of the cattle subjected to it, contrasting most strikingly with ordinary rinderpest, which kills from 80 to 90 per cent. of those affected. And, just as in the case of vaccination, this modified and mild form of the disease confers protection against it in its most virulent condition; so that even the beasts in which the treatment had produced no symptoms at all remained absolutely unaffected when tested subsequently with a dose of infective material sufficient to kill 10,000 full-grown oxen. This immunity is also of a very lasting character; and, indeed, so far as experience has yet gone, it may be as permanent as that caused by an ordinary attack.

This process was very extensively employed as a prophylactic in the herds of South Africa, during the raging of the epidemic, and with most remarkable success. According to an estimate based on the Cape Government statistics, the effect of the preventive inoculations carried out during the last two years, including those by Koch's method, has been to cause the saving of the lives of upwards of 700,000 head of cattle. It is believed that, had it not been for these prophylactic labours, the number of cattle remaining in the country, instead of being, as now, upwards of a million, would have been little more than 300,000. And it is to be remembered that these are the gross results, including not only those of the present method, but also those of the comparatively imperfect processes that led up to it.

Assuming, as I believe we may, that the report from which these statements are drawn is entirely worthy of confidence, we have here a striking example of beneficent application of science.

Among the many important matters that have come before us during the past year, some in the domain of chemistry seem to stand out as especially striking. One of these is the liquefacton of hydrogen by Prof. Dewar. In previous attempts by Olszewski and himself, drops of clear liquid had been seen which it was supposed were composed of that element; but no one could be quite sure that these were not merely the result of the condensation of other gases which it is extremely difficult to get rid of completely. None could be certain that hydrogen, if liquefied, would not present, like mercury, the appearance of a metal. Dewar, however, after long continued persevering effort, succeeded in producing a liquid in bulk, with well defined meniscus, which, in one of his wonderfully effective vacuum-coated vessels, could be manipulated experimentally, as liquid air had been, allowing at once the determination of some of its physical constants, and liquefying the previously refractory helium, implying a lower temperature than had ever before been attained by man. This achievement is not only of supreme interest in itself but opens up an entirely new field for investigations into the properties of matter.

Liquefied gases have been the means by which Prof. Ramsay has been able to obtain his recent very remarkable results. As chairman of the Chemical Section of the British Association at Toronto he had boldly taken as the subject of his opening address an unknown element, of the existence of which he felt confident from theoretical considerations. He believed that there must exist such a body with an atomic weight intermediate between those of argon and helium. He sought for this element, hoping to find it locked up, like helium, in some mineral, and in other ways tried to discover it. But in a paper presented to the Society early in this year, he was obliged to confess that all his efforts had been fruitless. At the same time in that paper he again expounded his reasons for believing in the existence of the unknown body. He has since adopted a new line of investigation. Having at his disposal a large supply of liquid air, he tried with it the method of fractional distillation; and after allowing the main bulk to evaporate, proceeded to volatilise and test the residue. In this he did indeed find what appears to be a new elementary body, to which he gave the name of Krypton. But so far from complying with his requirements, this gas was found to be much denser than argon; indeed it is thought probable by Ramsay that it has twice its density, and therefore, being, like argon, monatomic, twice its atomic weight. Ramsay, however, had another resource at his command. Aided by Mr. Travers, who has throughout this inquiry most ably seconded him, he had, by long continued labour, procured a large store of argon. This he liquefied by subjecting it to the cold of boiling liquid air; and surmising that any element lighter than argon would be present in the superjacent vapour, he collected this and subjected it to analysis. And now he found what he had so long sought for, a new elementary gas with atomic weight intermediate between those of argon and helium. To this he gave the name of Neon.

But this was not all. As the argon liquefied at the low temperature caused by boiling liquid air, a white solid was seen to be deposited in it, and this remained after all the liquid had evaporated. This solid, on being volatilised and tested, was found to be, as is believed, another new element. This, though very unlike argon in physical characters, possesses a nearly, if not absolutely identical atomic weight; just as some metals with very similar atomic weights differ in their qualities. This element has therefore received the appellation Metargon.

Such is a most rough sketch of two samples of the work of the Society during the past year.

The President then proceeded to award the medals.

The Copley Medal is awarded to Sir William Huggins for his great achievements in the application of spectrum analysis to the heavenly bodies.

His first results in this direction were obtained early in 1864. At the commencement of his labours in his observatory at Tulse Hill, he worked in conjunction with the late Prof. Miller. By visual observation a multitude of lines in the spectra of Betelgeux and Aldebaran were carefully measured, mapped, and compared with those of terrestrial elements. This is notable as being the first application of thoroughly precise methods to the study of the spectra of stars, and as showing the presence of terrestrial elements in them.

On August 29, 1864, Huggins discovered the bright line spectrum characteristic of certain nebulae. This must always be regarded as one of his chief titles to fame. It was an epoch-making discovery, for it established in an unquestionable manner that some of these objects were veritably gaseous. The interest of this work was greatly increased by the fact that, by comparison with the spectrum of terrestrial hydrogen, Huggins showed that one of the nebular lines belonged to that substance.

In 1868, Huggins applied the principle of Doppler to the measurement of stellar movements in the line of sight. He thus originated a department of spectroscopy which has been considered to be perhaps the most instructive application of spectrum analysis to astronomy. Notable results were obtained by Huggins himself in the application of this method, and it has led to many remarkable developments in the hands of other astronomers. By following the course which Huggins originated, wholly new classes of double stars have been revealed, the movements of Algol have been explained, and the mathematical theory of Saturn's ring has been visually confirmed.

The appearance of Winnecke's comet, in the year 1868, gave Huggins the opportunity of studying, for the first time, the spectrum of one of those bodies. He found bright lines in the spectrum of the comet which agreed with those of olefiant gas. Thus he established the fact that carbon was a constituent of comets.

The spectrum of Vega had been photographed by H. Draper, in 1872. In 1876, Huggins obtained a photograph of the spectrum of the same star. He then discovered the remarkable series of hydrogen lines characteristic of the spectra of the class of so-called white stars which includes Sirius as well as Vega. The very beautiful system of hydrogen lines in this ultra-violet

spectrum was described by Huggins to the Royal Society in 1879.

In 1881, Huggins succeeded in photographing the spectrum of Tebbutt's comet, and, availing himself of the various improved appliances which were suggested by his unique experience, he photographed the spectrum of the Orion nebulae in 1882. In 1888, a still better photograph of the same spectrum was obtained by Dr and Mrs. Huggins. There was a special interest about this plate. It showed that certain bright lines were common to the nebula and to the trapezium stars, thus establishing the connection between the stars and the nebulae. Further investigations of the same object were also made in 1889 In that same year the spectrum of Uranus was investigated photographically by Dr. and Mrs. Huggins, and was shown to be essentially solar. In 1890, the chief line in the nebular spectrum was accurately re-determined, and an investigation was made by Dr. and Mrs. Huggins of the spectra of Wolf and Rayet's stars in Cygnus.

The most recent work from the Tulse Hill Observatory has been the investigation of the remarkable ultra-violet lines of calcium, by which the characteristics of these lines in the solar spectrum have been explained.

A sketch of the early history of spectroscopic astronomy was given by Dr. Huggins to the British Association, at Nottingham, in 1866. A review of the same subject a quarter of a century later is found in his Presidential Address at the Cardiff Meeting of the Association in 1891. Reference must also be made to a lecture on the remarkable star, Nova Aurigae, given at the Royal Institution in 1892.

A full list of Huggins's papers, up to the year 1894, is found in Frost's translation of Scheiner's "Astronomical Spectroscopy," published by Ginn and Co., 1894

The Rumford Medal is given to Prof. Oliver J. Lodge in recognition of his researches on radiation and on the relations between matter and ether.

In dealing with the history of the discovery by Prof. Hertz of electro-magnetic radiation, it would be impossible to pass over the work done previously, or simultaneously, by Prof. Lodge, on the surging or oscillatory character of the transmission of electric discharges along wires.

Prof. Lodge gave an account of his observations in his lectures to the Society of Arts, delivered in 1888, which are incorporated in his treatise on "Lightning Conductors and Lightning Guards," published in 1892.

The researches of the English and German physicists were entirely independent, and though the merit of the actual discovery of electro-magnetic radiation belongs certainly to Prof. Hertz, there seems little reason to doubt that Prof. Lodge's experiments would have led him eventually to the same result. Prof. Hertz himself says, in the introduction to his work, "Ueber die Ausbreitung der Elektrischen Kraft": "Inasmuch as he" (Prof. Lodge) "entirely accepted Maxwell's views, and eagerly strove to verify them, there can scarcely be any doubt that, if I had not anticipated him, he would also have succeeded in observing waves in air, and thus also in proving the propagation with time of electric force" (p. 3, English edition).

When the discovery of electro-magnetic radiation was announced, Prof. Lodge at once recognised its great importance, and by his lectures and writings contributed largely to make known to this country the brilliant achievement of Hertz. At the same time, by his experimental investigations, he added considerably to the knowledge of the subject, and materially strengthened the evidence that electro-magnetic waves exhibit similar properties to those which have been for a long time assigned to the ethereal disturbances assumed to constitute the mechanism by which are produced the phenomena of light.

Prof. Lodge's introduction of the "coherer"—an instrument the action of which is based on observations made independently by himself and M. Branly as a substitute for the Hertz "resonator," has increased in a marked degree the facility for reproducing and extending the experiments of Prof. Hertz, and has furnished the means of exhibiting much more conspicuously the results obtained.

More recently Prof. Lodge has been engaged in investigating the phenomena presented by the Rontgen rays, and the circumstances under which these rays are produced. He has also studied the effect on the light emitted from a source placed in a powerful magnetic field, which was discovered by Prof. Zeeman.

In connection with all these branches of inquiry, he has communicated to scientific societies and to periodicals a large number of papers, containing valuable contributions to our knowledge of radiations in ether, and suggestive speculations as to the properties of the ether itself.

With the object of obtaining some information as to the properties of the ether, and of ascertaining whether any mechanical connection can be detected between matter and ether, Prof. Lodge carried out an elaborate series of experiments, of which the record appears in the *Philosophical Transactions*, vols. 184 and 189 The special aim of this research was to determine whether a moving mass communicates any corresponding motion to the ether in its immediate neighbourhood, or, in other words, to determine whether the ether has any apparent adhesion to matter, and possesses any property of the nature of, or analogous to, viscosity.

His method of observation is to divide a beam of light into two of equal intensity, and to cause the latter to traverse in opposite directions an annular space in a steel or iron disc. The two beams are superposed so as to produce interference-bands. If any appreciable motion can be communicated to the ether in the annulus by causing the disc to revolve rapidly round the common axis of the disc and annulus, it is practically certain that some change must be produced in the velocity of the light in the two beams, and this change must show itself by an observable displacement of the interference-bands.

No such displacement was observed with any velocity of the disc which could be attained, nor could any shift of the bands be detected when the annulus in the revolving disc was converted into a powerful magnetic field, or was subjected to strong electrification.

The absence of any noticeable effect upon the light in these experiments is taken to indicate that matter has no appreciable hold upon the ether in its neighbourhood, and that no power of gripping the ether is conferred upon matter either by magnetisation or electrification of the kind employed.

[As it is a condition that a part at least of the work on which a claim to the Rumford Medal can be founded should have been published during the two years preceding the award, a list is appended containing the titles of some of Prof. Lodge's papers which have appeared during 1896-98:—

(1) "Experiments on the Absence of Mechanical Connection between Ether and Matter" (*Phil. Trans.*, A, 1897, vol. 189).

(2) "The Influence of a Magnetic Field on Radiation Frequency" (*Roy. Soc. Proc.*, vol. 60).

(3) "Further Note on the Influence of a Magnetic Field on Radiation Frequency" (*Roy. Soc. Proc.*, vol. 61).

(4) "Note on Mr. Sutherland's Objection to the Conclusiveness of the Michelson-Morley Aether Experiment" (*Phil. Mag.*, vol 46).

(5) "On the Rays of Lenard and Rontgen" (*Electrician*, vol. 46).

(6) "On the Present Hypotheses concerning the Nature of Rontgen Rays" (*Electrician*, vol. 36).

(7) "Further Progress in Radiography" (*Electrician*, vol. 36).

(8) "Rontgen Rays" (*Electrician*, vol. 37).

(9) "The Surviving Hypothesis concerning the X-Rays" (*Electrician*, vol. 37).

Several short notes on subjects connected with Radiation have appeared in NATURE during 1896-98.]

One of the Royal Medals is bestowed upon the Rev. John Kerr, as the author of extremely important experimental researches on the optical relations of electricity and magnetism.

Dr. Kerr has made a name, which will always be remembered in the history of science, by his experiments on the optical effects of electrical and mechanical stress, and on the polarisation of light reflected from the surface of a magnetised body.

His observations on electrical stress were recorded in a series of papers published in the *Phil. Mag.* in 1875, 1879 and 1882, in which he demonstrated the fact that the velocity of polarised light in a body subjected to electrostatic influence is different according as the plane of polarisation is parallel or perpendicular to the lines of electric force.

In these experiments he was led to use mechanically strained glass as an auxiliary apparatus, and in October 1888, he published, in the *Phil. Mag.*, an important paper on "The Birefringent Action of Strained Glass."

In 1877, Dr. Kerr (*Phil. Mag.* [5], vol. 3, p. 321) showed that if plane polarised light is reflected from a magnetised surface, the polarisation of the reflected ray is affected by the

magnetic state of the surface This result was of the highest theoretical interest, and it has been a matter of admiration and wonder to subsequent investigators that Dr. Kerr should have been able to learn so much with the comparatively simple and ineffective apparatus at his disposal.

Both of Dr. Kerr's great researches have been the starting points of numerous inquiries. His experiments on electrical stress have been repeated and extended by Gordon, Quincke, Röntgen, and others, while Fitzgerald, Righi, Kundt, Lorentz, Sissingh, Zeeman, J. J. Thomson, Du Bois, Goldhammer, Drude and Leathem, are among those who have been occupied with the extension or theoretical meaning of his work.

Dr. Kerr's researches rank among the most important of those which have been made since the time of Faraday.

The other Royal Medal is conferred on Mr. Walter Gardiner, who has taken a leading part in what is perhaps the most important recent advance in Vegetable Histology, namely, the discovery that the protoplasm in the tissues of plants is continuous from cell to cell, and not broken up into isolated portions by the cell-walls. His first work on the subject dates from 1882, when he published in the *Quarterly Journal of Microscopical Science* a short paper on "Open Communication between the Cells in the Pulvinus of *Mimosa pudica*." Up to that time protoplasmic continuity in plants had only been recognised in the special case of the sieve-tubes and in the endosperms of three species; and even in these instances the evidence that the connecting threads were really of protoplasmic nature was not, in Mr. Gardiner's opinion, conclusive.

In 1883 he presented to the Royal Society an extensive memoir "On the Continuity of the Protoplasm through the Walls of Vegetable Cells" (*Phil. Trans.*, pt. 3, 1883), in which he demonstrated that this structure is constant in the endosperm, and that it also occurs in various tissues of the plant. Mr. Gardiner at that time thought it probable that the phenomenon might be of universal occurrence, and dwelt on its great physiological significance.

In the meantime other observers took up the subject, and the generality of protoplasmic continuity in plants came to be widely recognised by botanists. Mr. Gardiner, however, was severely critical of his own methods and results, and was not satisfied that the evidence, though conclusive in so many cases, was strong enough to bear the weight of so wide a generalisation. He therefore set himself, within the last few years, to re-investigate the subject, with the aid of more refined processes which he had adapted and elaborated.

The results of his renewed work were communicated to the Royal Society last year, in a paper on "The Histology of the Cell-wall, with special reference to the Mode of Connection of Cells" (*Roy. Soc. Proc.*, vol. 62, p. 100). In this work he shows for the first time, that the connecting fibrils of protoplasm can be demonstrated with certainty in all kinds of vegetable tissues, and he is also enabled to make the important statement that "the threads appear to be present *ab initio*."

Mr. Gardiner has done much good work in other departments of the Histology and Physiology of Plants, notably on glandular structures; on the function of tannin; on protoplasmic contractility; and on the phenomena accompanying stimulation in insectivorous plants. His scientific reputation, however, rests chiefly on the fact that to him, more than to any other investigator, is due the discovery of the continuity of protoplasm in plants—a discovery which essentially modifies our whole conception of vegetable organisation.

The Davy Medal is awarded to Prof. Johannes Wislicenus for his numerous and important contributions to Organic Chemistry, embodied in a series of papers extending over the last thirty-five years, and published in the *Berichte* of the German Chemical Society, Liebig's *Annalen*, and elsewhere. The researches undertaken by Prof. Wislicenus and his pupils, inspired by the zeal of their master, have flowed, almost without intermission during the period mentioned, from the laboratories of Zürich, Würzburg and Leipzig. Among his earlier work may be mentioned his classical researches on the lactic acids, which finally settled the much-debated questions concerning the combination of acid and alcoholic properties in oxy-acids in general. These researches threw much light on the subject of the isomerism of the oxypropionic acids. He ascertained the nature of the action of silver oxide on β-iodopropionic acid, while his improved synthesis of ordinary lactic acid from aldehyde, and of β-oxypropionic acid from glycollic chlorhydrin, established the relations of these acids to their respective radicles, ethylidene and ethylene. His study of sarcolactic acid was a notable contribution to the subject of the optical activity of organic compounds, and resulted in the important discovery for the first time of two substances having a structure of proved chemical identity, and yet possessing different physical properties.

The prominent part taken by Wislicenus in unravelling the reactions concerned in the formation of aceto-acetic ester, and in the application of this compound as a synthetical agent, is well known to all chemists. He devised a practical method for its preparation, and was the first to use the isolated substance as the starting point of synthetical operations. He defined the acid property of the replaceable hydrogen atom in this ester, and its homologues, and devised the now familiar methods for the use of the sodium derivatives in organic syntheses. He discovered the "acid" decomposition of the ester and its derivatives, and established the conditions under which the "ketonic" decomposition could be effected. He utilised his methods for the synthesis of compounds of the most varied types, such as mono- and polybasic acids, both saturated and unsaturated, oxy-acids and ketonic acids, ketones and alcohols.

More recently the name of Wislicenus has become closely associated with discovery in the new field of stereo-chemistry. As early as 1869 he pointed out the insufficiency of the ordinary "constitutional" formulae to explain the isomerism of ordinary and active lactic acid, and clearly stated that the explanation was to be found in the tridimensional arrangement of the atoms in space. Van 't Hoff states that it was this statement by Wislicenus which suggested to him the ideas which culminated in his well-known theory of the asymmetric carbon atom. Wislicenus boldly advocated the introduction of geometrical conceptions into the doctrine of the constitution of chemical molecules, and in his memoir "Ueber die räumliche Anordnung der Atome in organischen Molekulen," published in 1887, he extended the hypothesis of van 't Hoff, and showed how the spacial arrangements could be determined in special cases. The new ideas contained in this memoir had a most stimulating effect on the study of stereo-chemical isomerism. Of his own and his pupils' work in this field may be mentioned investigations of the tolane dichlorides, acetylene-dicarboxylic acid, the butylenes and derivatives of crotonic acid.

The Darwin Medal is given to Prof. Karl Pearson in recognition of the great biological importance of his work upon the Theory of Probability, and its relation to vital statistics. The importance of the theory of probability in dealing with the problems of organic evolution was first seen by Mr. Francis Galton. Prof. Pearson's merit lies in the fact that he has so far extended the mathematical theory of chance as to make it possible to treat generally problems which could previously be dealt with only in a few special cases. Prof. Pearson has shown, in various memoirs published in the *Philosophical Transactions* during the last five years, that the amount and frequency of organic variation, the degree of interdependence between one variable organ and others, the phenomena of heredity, and the intensity of selective destruction can be treated quantitatively by means of his development of the calculus of probability; and he has given examples of the treatment of variation and inheritance in man, and in a number of animals and plants.

A calculus by which the fundamental phenomena of organic evolution can be treated quantitatively provides an engine of biological research of a new and powerful kind, and, as a stimulus to new and more accurate investigation of the phenomena of organic evolution, it is of very great importance. The hypothesis of natural selection has hardly been proved by the direct demonstration of a selective death-rate, except in few and simple cases. The demonstration of such selective death-rate in more complex cases is rendered possible by Prof. Pearson's work. Such demonstration is the natural and logical sequel to the work of Darwin himself, and there is a peculiar fitness in awarding the Darwin Medal to the man who has made it possible.

The Society next proceeded to elect the officers and Council for the ensuing year. The list has already appeared in NATURE (p. 39).

In the evening the annual dinner took place at the Whitehall Rooms. Among the guests of the Society who made speeches were the Lord Chancellor, Lord Kitchener, and Lord Curzon.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The completion of the fiftieth year of Sir George Stokes' tenure of the Lucasian Professorship will be celebrated by the University on June 1 and 2, 1899. Invitations to assist will be issued to distinguished representatives of universities and learned societies, British and foreign. A grant of 400*l*. has been made by the University for the purpose, and it is understood that some permanent memorial of the occasion will be provided.

The Walsingham Medal has been awarded to Mr. J. Graham Kerr, of Christ's College, for his researches on *Lepidosiren*. Mr. A. C. Hill, of Trinity, is *proxime accessit*, and five other essays are pronounced by the adjudicators to be of a high order of merit.

A John Lucas Walker Studentship in Pathology, value 200*l*. a year for three years, is about to be vacant. Candidates, who may be of either sex, are to send in their names to Prof. Kanthack by January 18, 1899.

An Isaac Newton Studentship in Astronomy, value 200*l*. a year for three years, will be filled up next term. Candidates must be B.A.s under the age of twenty-five on January 1, 1899. Names are to be sent into the Vice-Chancellor between January 16 and 26.

The Sheepshanks Telescope Committee report that the erection of the polar-reflecting photographic telescope at the Observatory, with its building and dome, is nearly complete. Dr. Common has provided the mirror, and the object-glass is one of Cooke's triple lenses. The tube and apparatus are by Messrs. Grubb. The adjustments and tests have still to be carried out.

Mr. Shipley and Mr. Cronin are to represent the University at the centenary of the Imperial Military Academy at St. Petersburg at the end of this month.

INFORMATION of two examples of munificence to education and science reaches us from the United States. Mrs. Emmons Blaine has given 250,000 dollars to Chicago University for the establishment of a college for teachers. Miss Anna T. Jeanes has recently presented the Academy of Natural Sciences of Philadelphia with 20,000 dollars, the income to be used for museum purposes.

THE following Scholarships have been awarded in connection with the present Session 1898-99 of the Central Technical College:—Clothworkers' Scholarship, 60*l*. a year, to A. J. Cook; Mitchell Scholarship, 50*l*. a year, to R. H. Collins; John Samuel Scholarship, 30*l*. and free education, to F. C. Hounsfield; Institute's Free-Studentships to R. H. Buckie, A. W. Harrold, and W. H. P. Brounger.

THE *British Medical Journal* states that Mr. Alfred L. Jones has offered the sum of 350*l*. a year to establish and maintain a laboratory in Liverpool for the study of tropical diseases. The laboratory will be opened in association with the Royal Southern Hospital, and a Committee has been formed to carry out the scheme in connection with the hospital and with University College.

THE first number of a new monthly magazine, devoted to the principles and practice of teaching the subjects usually studied in secondary schools—by which is meant all schools, public and private, other than public elementary schools—will be published by Messrs. Macmillan in the middle of January next, under the title of *The School World*. The magazine is not designed to be an educational newspaper so much as a periodical for the publication of articles on methods of teaching, and of notes by experienced teachers on the treatment of difficulties met with in actual school work. Rational methods of teaching will be advocated so far as they are practicable under existing conditions in secondary schools, and articles will be published showing how they can be carried out. Among the contributors to the scientific section of early numbers of the magazine will be Prof. L. C. Miall, on experimental natural history; Prof. G. B. Mathews, on the teaching of algebra; and Dr. Francis Warner, on physical observations of boys and girls in schools. Other scientific subjects to be dealt with are the stars month by month, current geographical topics, and experimental general science.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, November.—The first "Cambridge Colloquium" was held at Buffalo in 1896. In consequence of the British Association holding its meeting in 1897 at Toronto there was no Colloquium held in that year. The second Colloquium was held in the present year (August 22-27), at Harvard University. Two courses of six lectures each were delivered, the lecturers being Profs. Osgood and Webster. The latter gentleman took as his text "The partial differential equations connected with wave propagation"—an abstract of this course is to be given in a future number. Prof. Osgood lectured "On some methods and problems of the general theory of functions." Lecture i. was devoted to Picard's theorem, and the application of Riemann's geometric methods in the general theory of functions. Lectures ii. and iii. discussed the representation of multiple-valued functions by means of single-valued functions of a parameter, treated geometrically by Riemann's methods and also Poincaré's theorem. Lectures iv. and v. dwelt on some recent study of the relation between the properties of a function defined by a power series and the coefficients of that series. The last lecture was on certain Cantor's sets, and their application in a question concerning Cauchy's definition of an analytic function. The lectures are very fully reported, and illustrated with diagrams and bibliographical notes. The "Colloquium" is a very interesting and useful addition to the ordinary meetings of the Society. The above meeting was held at the same time as the American Association for the Advancement of Science held its semicentennial meeting, at which about 900 members were present. The section of mathematics and astronomy was well attended. The committee of the section accepted twelve papers in pure mathematics, thirteen in applied mathematics, and sixteen in astronomy. The titles of these are given, and short abstracts of their contents follow. Interesting notes and a list of recent mathematical publications close the number. The *Bulletin* well maintains the high position it has attained.

American Journal of Mathematics, vol. xx. No. 4, (October 1898).—Sur l'intégration hydraulique des équations différentielles, by M. M. Petrovitch. The author writes: "Tous les intégraphes et les appareils pour l'intégration graphique des équations différentielles, proposés jusqu' aujourdhui, sont fondé sur l'emploi de certains principes cinématiques, p. ex. sur les propriétés des roulettes (*cf.* the Catalogue of Models, Apparatus and Instruments, by W. Dyck, Munich, 1892-3)." He shows briefly that these integrations can be effected in quite another way. "Supposons que l'on fasse immerger un corps solide M plus ou moins profondément dans le liquide contenu dans un vase B. Le niveau du liquide montera ou s'abaissera d'après une certaine loi dépendant de la forme du corps M et du vase B et ces formes une fois fixées, la variation de la hauteur du niveau y, comptée à partir d'un plan horizontal fixe, p. ex. à partir de la face inférieure du vase B ne dépendra que de la distance x entre l'extrémité e de la tige ef et la face inferieure du vase B." The principle is applied to the graphical integration of a certain type of differential equations of the first order. The article is illustrated with a few diagrams.—On the hyperelliptic sigma functions, by H. F. Baker. This memoir, which occupies pp. 301-384, appears to be a brilliant contribution to the literature of the Riemann surface.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 24.—"The Origin of the Gases evolved on heating Mineral Substances, Meteorites, &c." By Morris W. Travers, D.Sc. Communicated by Prof. W. Ramsay, F.R.S.

Conclusions.

It would appear that the only evidence on which the assumption that gases of a permanent character, such as hydrogen, carbon monoxide, nitrogen, helium, and argon, exist in the free state in the mineral substances from which they are evolved on heating, rests on certain observations with regard to the cavities which can sometimes be detected by microscopic examination.

The cavities may be either apparently empty or they may contain liquid, and when the mineral is warmed the liquid

disappears at a temperature which is a few degrees below the critical point of carbon dioxide or of some hydrocarbon. The fact that the critical temperature of the liquid is a little below the point corresponding to carbon dioxide, in the case of a mineral containing that substance is not, however, of very great significance as pointing to the presence of a permanent gas. A small quantity of methane would produce the same result (Kuenen, *Phil. Mag.*, 1897).

Further, although it can be shown that *compact* minerals do enclose carbon dioxide and hydrocarbons, gases which can easily be liquefied, the analogy cannot be extended to gases such as hydrogen and helium in connection with minerals like chlorite, mica, and clevite, which exhibit many cleavages.

On the other hand, there is, as I have endeavoured to show, a considerable amount of evidence in favour of the theory which I have put forward:—That in the *majority of cases* where a mineral substance evolves gas under the influence of heat, the gas is the product of the decomposition or interaction of its *non-gaseous* constituents at the moment of the experiment. The results of such experiments cannot, therefore, serve as basis for speculation as to origin and history of the substances in question.

Geological Society, November 2.—W. Whitaker, F.R.S., President, in the chair.—Sir A. Geikie drew attention to some specimens on the table which had been collected by the Geological Survey from the Silurian rocks of County Tipperary. These contained impressions that bore a close resemblance to flattened and drawn-out graptolites, and others that might be taken for mollusca or phyllopoda enlarged by cleavage. It seemed to him, however, extremely doubtful whether these forms were truly of organic origin. They were exhibited in the hope that the palaeontologists in the Society might be able to throw some light upon them from the zoological side.—Dr. G. J. Hinde exhibited and commented on specimens of Devonian rocks sent by Prof. Edgeworth David and Mr. Pittman from the railway-section at Tamworth, New South Wales, which had been received since their paper was read.—Note on a conglomerate near Melmerby (Cumberland) by J. E. Marr, F.R.S. In this paper the author describes the occurrence of a conglomeratic deposit which shows indubitable effects of earth-movement, not only on the included pebbles, but also on the surface of one of the deposits. The rocks are coloured as basement Carboniferous rocks on the Geological Survey map. Sir A. Geikie remarked that in his opinion the author had completely proved the point sought to be established. The peculiar features of the conglomerate described in the paper were obviously due to earth-movements, and not to glacial action. At the same time, while frankly admitting the explanation of the case now brought forward, he held that conclusive evidence had been obtained of glacially-striated boulders in old geological deposits. Other speakers supported Dr. Marr's view that the surface-features of the stones exhibited were due, not to glacial action, but to earth-movements. The author, in reply, stated that he had brought the case forward simply as an example which might be appealed to in future discussions, as showing exceptionally good indications of the various features produced by slickensiding.—Geology of the Great Central Railway (New Extension to London of the Manchester, Sheffield and Lincolnshire Railway): Rugby to Catesby, by Beeby Thompson.—On the Remains of *Amia* from Oligocene Strata in the Isle of Wight, by E. T. Newton, F.R.S.

Entomological Society, November 16.—Mr. R. Trimen, F.R.S., President, in the chair.—Mr. Tutt showed, for Mr. Herbert Williams, a series of specimens of *Pararge egeria* bred from eggs laid in July. A portion of the brood were forced, and the imagos, which emerged in November and December of the same year, showed marked darkening of the hind margin of the under side of the hind wings, and were of a greyer colour than those which appeared at the normal time. He also exhibited a batch of fifty specimens of *Amphidasys betularia* bred from ova deposited by a female captured in Essex. The progeny ranged from a colour rather lighter than the normal form to a blackish tint almost equal to that of var. *doubledayaria*; all intergrades were represented without sign of discontinuity.—Mr. H. J. Elwes gave an account of a journey undertaken by him in June and July of the present year to the Russian portion of the Altai mountains, partly for sport and partly to investigate the distribution of insects in that region, and the line of demarcation between the Eastern and Western Palaearctic sub-regions. He exhibited samples of 141 species of butterflies taken by himself. Of these many had not been previously recorded from the region, of which the total number of species now stood at 184; his list showed that the lepidopterous fauna had a more European and Siberian character than had been previously supposed, or than Seebohm had found to exist in the avifauna. The number of undescribed species taken was small, but several forms were previously known only from remote localities, such as *Melitaea iduna*, hitherto recorded from the fells of Lapland. Few Heterocera were taken, but among them was the third recorded example of *Arctia thulea*, Dalm.—Dr. A. G. Butler communicated a paper on some new species of African Pierinae in the collection of the British Museum, with notes on seasonal forms of *Belenois*.

Linnean Society, November 17.—Dr. A. Günther, F.R.S., President, in the chair.—Prof. Stewart, F.R.S., exhibited and made remarks on the skull of a fox that was described and figured by Bateson in his work on variation. Both upper canines had divided crowns. He also exhibited the double tusk of an Indian elephant. The tusk was two feet in length, and had a deep groove on its anterior and posterior surfaces. He considered that in both cases the condition was probably due to partial cleavage or grooving of the dental papilla. The President, referring to the exhibition of a somewhat similar tusk at the previous meeting, indicated the points in which the two examples differed.—A paper was read by Mr F. Pickard Cambridge on some spiders from Chile and Peru, collected by Dr. Platte of Berlin. The collection was made during a journey extending from Tumbez, in Northern Peru, down the coast of Chile to Cape Horn, and contained nineteen species, of which seven proved to be new to science.—Mr. Spencer Le M. Moore read a paper entitled "The botanical results of a journey into the interior of Western Australia; with some observations on the nature and relations of the desert flora, and on the probable origin of the Australian flora as a whole." The author briefly sketched the physical and botanical features of the West Australian desert, indicating the parallel of 30° S. as, at least in the Coolgardie district, the dividing line between two subfloras. Flowering takes place almost entirely in spring time, when alone the conditions are favourable to it. Statistics of the desert-flora were then given. These comprise 867 known species, of which 860 are Phanerogams, referable to 319 genera, distributed among 73 natural orders. Of the flora 58 per cent. consist of species ranged under 8 orders, with *Compositae* and *Leguminosae* heading the list, leaving 42 per cent. to be shared between the remaining 65 orders. The author disbelieved the current theory of Scandinavian predominance; and the prevalence in Eastern Australia of forms of Indo-Malayan facies was held to be due, in great measure, not to immigration, but to descent from the primitive Tertiary flora. Moreover, the balance of exchange between Indo-Malaya and Australia in favour of the former area, was considered as coming under the doctrine of chances, and not as implying any inherent superiority of the one flora over the other. While in Europe the Australian, *i.e.* the xerophilous, element was, owing to change in climate, eliminated in favour of the present hygrophilous vegetation, in Eastern Australia the conditions remained as they were in earlier Tertiary times until desiccation set in. He held that this desiccation dates from an earlier period in Western Australia; and that this, together with the isolation of the Western portion of the continent in Secondary times by a sea, and later by stretches of desert, explains the floristic difference between the two halves of Australia. Mr. C. B. Clarke, F.R.S., made some observations on the origin of the Australian flora, and on the dispersal northwards of species from the Antarctic.—The President made some remarks by way of comparing the botanical statistics mentioned by Mr. Moore with the results obtained by zoologists in Australia, both as regards the character and origin of the fauna.

Zoological Society, November 29.—W. T. Blanford, F.R.S., Vice-President, in the chair.—Mr. G. A. Boulenger, F.R.S., exhibited a dancing-stick from New Guinea, to which were attached as ornaments two imperfect skulls of the rare Chelonian *Carettochelys insculpta*, a species previously known only from a single specimen in the Australian Museum, Sydney. Mr. Boulenger also exhibited and made remarks upon a large female specimen of a sea-snake, *Distira stokesi*, which had been caught by Mr. F. W. Townsend in Kurrachee Harbour covered with a thick growth of green seaweeds.—Mr. C. W. Andrews

exhibited and made remarks on some bird remains which had been obtained from excavations at the Lake-dwellings near Glastonbury, Somersetshire, and among which were numerous bones of a Pelecan.—Mr. Oldfield Thomas read a letter which he had received from Señor Ameghino on the subject of the newly discovered mammal *Neomylodon*, giving further information, obtained from the Indians, as to its distribution, characters, and habits.—A communication was read from Dr. E. A. Goeldi on the Amazonian Lepidosiren, in which he recorded the capture of two further examples of this Dipnoan in the island of Marajo. Dr. Goeldi gave a short description of the physical features of the locality in which he had found Lepidosiren—a "pirisal" or papyrus-meadow. He also referred to the live specimen in his aquarium which had recently developed branches on its fore limbs. Dr. Goeldi pointed out the gill-like character of the fore limb, and adduced it as a support to the Gegenbaur theory of limbs. He also suggested the possibility that the so-called fore limb of Lepidosiren is not a true fore limb, but a persistent external gill. This paper was illustrated by the exhibition of three specimens of the Amazonian Lepidosiren, which Dr. Goeldi had forwarded for presentation to the British Museum.—Mr. F. G. Parsons read a paper on the anatomy of adult and foetal specimens of the Cape Jumping Hare (*Pedetes caffer*). In it the different systems—osseous, muscular, nervous, circulatory, digestive, &c.—were described in some detail, and contrasted with the corresponding parts in two Jerboas (*Dipus hirtipes* and *D. jerboa*).—A communication was read from Mr. F. O. Pickard-Cambridge on a small collection of spiders from Trinidad, West Indies. Specimens of six species were contained in the collection, of which three were described as new.—Mr. W. E. de Winton read some notes on the breeding of a female African Wild Ass (*Equus asinus*) in the Society's gardens, and called attention to certain facts as regards her offspring, which gave some support to the doctrine of telegony.—Mr. de Winton also read a paper describing the moulting of the King Penguin (*Aptenodytes pennanti*), as observed in a specimen in the Society's gardens. The author remarked that the specimen in question had lived in the gardens for sixteen months, and during that period had moulted only once.—A communication was read from Dr. A. G. Butler on a collection of butterflies made at Salisbury, Mashonaland, in 1898, by Mr. Guy A. K. Marshall. The collection contained specimens of sixty-five species, which were enumerated. Two new genera (*Torynesis* and *Tarsocera*) and one new species (*Aslauga marshalli*) were described in the paper.—Mr. G. A. Boulenger, F.R.S., read a third report on the additions to the Lizard Collection in the Natural History Museum, containing a list of this class (165 in number), new or previously unrepresented, of which specimens had been added to the collection since 1894.

Cambridge.

Philosophical Society, October 31.—Annual General Meeting.—Mr. F. Darwin, President, in the chair.—The following were elected officers for the ensuing year:—President, Mr. J. Larmor. Vice-Presidents: Mr. F. Darwin, Prof. Forsyth, Dr. Gaskell. Treasurer: Mr. Shipley. Secretaries: Mr. Newall, Mr. Bateson, Mr. Baker. Members of Council: Mr. H. Gadow, Mr. D. Sharp, Prof. J. J. Thomson, Mr. A. Berry, Mr. Wilberforce.—On the evaluation of a certain determinant, which occurs in the theory of statistics and of elliptic space, by Mr. A. Berry.—(1) Metrical relations between linear complexes, by Mr. J. H. Grace. In this paper are discussed the metrical relations which exist between the mutual moments and pitches of systems of four, five and six linear complexes. Some of the results are applied to a geometrical representation of a four-system of screws. (2) Apolar systems of quadrics.—Certain systems of quadratic complex numbers, by Mr. A. E. Western.—On Mittag-Leffler's theorem, by Mr. H. F. Baker.—The connection between the chemical constitution of a gas and the ionisation produced in it by Röntgen rays, by Prof. J. J. Thomson. The measurements of the ionisation produced by Röntgen rays in fourteen gases showed that the ionisation was connected with the chemical composition in a very simple manner. The ionisation was found to be an additive property.—On convection currents, and on the fall of potential at the electrodes in conduction produced by Röntgen rays, by Mr. J. Zeleny. During conduction through a gas exposed to Röntgen rays, convection currents are set up in the gas. When two parallel, plane electrodes are used, the motion of the gas begins symmetrically from the centre towards each of the plates. The motion is conveniently made visible by particles of ammonium chloride formed in the gas from ammonia and hydrochloric acid. Screening from the rays the space next to one of the electrodes increases the strength of the convection currents on that side. The cause of these currents is attributed to the motion through the gas near the electrodes of an unequal number of the two kinds of ions by means of which the conduction takes place.—On velocity of solidification, by Mr. H. A. Wilson. The relation between the velocity of solidification of a super-cooled liquid and the super-cooling has been investigated for a number of substances by G. Tammann and Friedländer (*Zeitschrift P. C.*, xxxiv. p. 152, 1897, and xxiii. p. 326, 1897). Assuming that the rate of solidification is directly proportional to the difference between the internal pressures in the liquid and solid and inversely proportional to the viscosity of the liquid, the velocity of solidification can be expressed by a simple formula.

November 28.—Mr. J. Larmor, President, in the chair.—(*a*) On the flame spectrum of mercury and its bearing on the theory of the distribution of energy in gases, by Prof. Liveing. The author had found that mercury heated in a flame of cyanogen, burning in oxygen, emitted at least two rays, at wave-lengths 2535 and 4358, which he had been able to photograph. The vibrations producing these rays must, he thought, be the result of a direct change of heat into vibratory energy; and if so, the ratio of the specific heats of mercury, at constant pressure and constant volume, proved only that, at the temperature of the compressed vapour in a sound wave, no very sensible proportion of the heat is converted into vibratory motion, though at a higher temperature a sensible proportion is so converted. This appears to negative the hypothesis that energy is always distributed equally in all the degrees of freedom of the molecules, as well as the assumption that a gas having 1·66 for the ratio of its specific heats must have monatomic molecules. (*b*) On the variation of intensity of the absorption bands of different didymium salts dissolved in water, and its bearing on the ionisation theory of the colour of solutions of salts. The author exhibited a series of photographs of the absorption bands produced by equivalent solutions of didymium nitrate and chloride, of which the strength was regularly graded, and the absorbent thickness varied.—Note on the vapour of iodine, by Prof. Dewar. The author had found that by careful distillation in vacuo films of iodine could be made so thin as to transmit light and exhibit the colours of thin plates by reflection. He exhibited experiments showing that at ordinary temperatures pure dry iodine emits vapour which, in a half-litre flask containing air, is sensibly coloured, whereas in similar circumstances, except that the air pressure was reduced, the colour is much less. This difference is enhanced as the temperature rises, so that at 100° it is very marked in a tube of only 1 cm. diameter.—On the partitions of numbers which possess symmetrical graphs, by Major Macmahon, F.R.S.

Manchester.

Literary and Philosophical Society, November 15.—Mr. J. Cosmo Melvill, President, in the chair.—Dr. G. H. Broadbent described the development and life-history of *Vorticella putrina* by means of thirty-four diagrams made from his own investigations. The cyst is circular in shape, the contents being finely granular, and the only indication of life is given by the contractile vesicle. This at first contracts at rare intervals and very slowly, and after a time an oral canal appears which gradually becomes more distinct, whilst the contractions of the vesicle grow more frequent. When the vorticella emerges from the cyst, a small portion is at first protruded through a very small aperture in the cyst-wall, in shape like a bladder, this gradually increasing in size until the whole creature has emerged, the aperture meanwhile appearing not to increase in the least. It is remarkable that after full extrusion the cyst-wall remains as large and as circular as before, whilst the organism is much larger than the cyst, and the vesicle greatly increased in size, thus indicating that the creature has been under great pressure in the cell. After emerging, the vorticella may remain quiescent for a time, until the basal cilia are developed, when it swims rapidly away as a "free-swimming" form. It afterwards attaches itself by the basal portion to some foreign body, and begins to shoot out a stalk which increases in length, while cilia are developed at the oral end. "Detached" as distinguished from "free-swimming" forms

were described, and it was shown that the development of basal cilia was always identified either with attachment to or detachment from the stalk.

DUBLIN.

Royal Dublin Society, November 16.—Mr. W. E. Wilson, F.R.S., in the chair.—Sir Howard Grubb, F.R.S., Vice-President of the Royal Dublin Society, read a paper on the correction of errors in the distribution of time signals. After referring to the various methods that are in use for the purpose of time distribution and the difficulties to be overcome, he described a system which he had recommended for a large institution in England, in which the conditions were somewhat similar to those of the Royal Dublin Society, though on a very much larger scale. He proposed that the best regulator clock should be procured and made to serve as the controlling clock of the whole system, which, however, would be further checked once every twenty-four hours by a signal from Greenwich, this being very much the same system as adopted at the Royal Dublin Society. The controlling clock, however, in this case he proposed should be sealed up in an air-tight case and in an atmosphere of nitrogen, and this placed in an outer case, or jacket, also containing nitrogen. By this means a constant pressure can be kept in the inside case, and with due precautions such a clock can be kept under conditions of constant pressure and temperature, and therefore should be expected to give extremely good results. This clock is then used to control a piece of uniform motion clock worked by a device very similar to what he has adopted with such success for his astronomical instruments, which has now been tested for several years and given excellent results. This piece of uniform motion clock is further checked by the Greenwich signal, it being supplied with a device by which the services of a human being to receive the signal and correct the clock are dispensed with. By an automatic arrangement the signal is received by this clock and corrected by exactly the amount it varies at that moment from the true time, and further a register is made of the amount of that correction, which can be afterwards inspected and noted. This uniform motion clock then serves as the central or distributing clock for some 200 other clocks spread throughout the building, which are practically only dials worked from this distributing clock.—Prof. G. A. J. Cole exhibited a method of intensifying the coloration imparted to a Bunsen flame by potassium in silicates. The minute assay is decomposed in a bead of sodium carbonate, as described in the *Geological Magazine*, March 1898. The method is of service in estimating the nature of the undifferentiated ground mass in many igneous rocks.

PARIS.

Academy of Sciences, November 28.—M. Wolf in the chair.—On the relation which exists between the progressive motion and the motion of inclination in the safety bicycle, by M. J. Boussinesq.—A differential method for determining variations of latitude and the constant of aberration, by M. G. Bigourdan. The method described is purely differential, and hence the results are free from errors inseparable from absolute measurements. It is independent of the stability of the telescope, and since only zenithal stars are employed, practically independent of refraction.—On the measurement of small diameters, by M. Maurice Hamy. The application of the interference method of Fizeau and Michelson is difficult for faint stars, the bands being scarcely visible. In the modification suggested the slits have a width which is appreciable compared with the distance of their centres, and hence the formula of Michelson is inapplicable. An approximate formula for the method thus modified is developed by the author. On some types of partial differential equations of the second order, by M. E. Goursat.—On orthogonal systems, by M. Tzitzéica.—On the complex multiplication of Abelian functions, by M. G. Humbert.—The mechanical equivalent of heat and the specific heats of gases, by M. A. Leduc. An application of the formulae developed in previous papers to determination of J from air and carbon dioxide. The deviations found are very large, and are due to the difficulty of measuring accurately the specific heat at constant pressure of a gas. The inverse calculation of this latter constant from the experimental value of the mechanical equivalent would probably be the better application of the formulae.—On condensed oxides of rare earths, by MM. G. Wyrouboff and A. Verneuil. The power of polymerising with great ease under a variety of conditions is especially characteristic of the ceroso-ceric group of oxides, and many reactions in this group can be more satisfactorily explained by this hypothesis than by the assumption of the formation of basic salts.—Observations on the spectra of aluminium, tellurium, and selenium, by M. A. de Gramont.—On the aromatic urethanes of tetra-hydroquinoline, by MM. Cazeneuve and Moreau. The urethanes were obtained by the action of an excess of tetrahydroquinoline upon the carbonates of phenyl, ortho-chlorophenyl, methoxy-phenyl, and α-naphthol.—On pulegenacetone, by M. Ph. Barbier.—Action of potash upon oxynitrocellulose, by M. Léo Vignon. The chief product of this reaction is oxypyruvic acid, $CH_2.(OH).CO.CO.OH$.—On a new crystalline principle extracted from *Artemisia absinthium*, by MM. Adrian and A. Trillat.—Researches on the means of increasing the adhesive power of copper solutions used for spraying diseased vines, by M. Joseph Perraud. Of the various substances tried, colophane proved to be by far the most effective, soap being the next useful.—Composition and food value of cheese, by M. Balland.—On a method of colouring living protoplasm by the pigments of fungi, by M. L. Matruchot.—Influence of anaesthetics on the formation of chlorophyll, by MM. E. C. Teodoresco and Henri Coupin. Chloroform or ether prevent the production of chlorophyll in etiolated plants exposed to the light. Used in quantities too small to completely prevent the formation of chlorophyll, the production of the green colouring matter was greatly retarded.—Geobotanical study of the flora of the high basins of the Sallanche and Trient, by M. Paul Jaccard.—On the discovery of fossils in the layers constituting in Provence the formation called *étage de Vitrolles*, and on the limit of the Cretaceous and Tertiary beds in the basin of Aix Bouches-du-Rhône, by M. G. Vasseur.—Measures proposed to avoid collisions at sea, by M. E. Lacoine.—Remarks concerning the green ray, by M. Piot-Bey.

NEW SOUTH WALES.

Royal Society, September 7.—Mr. G. H. Knibbs, President, in the chair.—Key to tribes and genera of Melanospermeae (olive-green seaweeds), by R. A. Bastow.—A study of the dialects of New Caledonia, by Jules Bernier, curator of the Musée Néo-Caledonienne. No less than twenty dialects are distinguished in New Caledonia, which are grouped into the following main divisions: the Southern, inclusive of the Isle of Pines; the Central; the Northern; and those parts of the Loyalty Islands peopled by Melanesians.—An interesting collection of photographs from the Don Dorrigo and Brush districts, New South Wales, chiefly geological, were shown by his Honour Judge Docker.—A new Eucalyptus oil was exhibited by Messrs. Baker and Smith of the Technological Museum, Sydney. On rectification this oil was found to contain a fraction boiling between 280°-290° C., equalling 18 per cent. of the whole, and which consisted almost entirely of eudesmol, comparatively in a pure condition. The fraction wholly crystallised in less than one hour.—The latest type of polariscope (Wright-Newton projecting polariscope) was exhibited by Dr. F. H. Quaife.

Linnean Society, October 26.—Prof. J. T. Wilson, President, in the chair.—On *Carabidae* from West Australia, sent by Mr. A. M. Lea (with descriptions of new genera and species, synoptic tables, &c.), by Thomas G. Sloane.—Descriptions of new species of Australian Coleoptera. Part v. by Arthur M. Lea.—A statistical note on variations in the flowers of *Anguillaria dioica*, R.Br, by C. T. Musson. As is well known, *Anguillaria dioica*, R.Br. (N.O. *Liliaceae*), is widely distributed in extra-tropical Australia and Tasmania, and occurs under three forms—with male flowers only (without even rudimentary pistils), with female flowers only (without even rudimentary stamens), and in a polygamous condition (with male, and hermaphrodite flowers). But whether or no all three forms occur together throughout the area of distribution, and if so in approximately what relative numerical proportions are matters not ascertainable from present records. From the data collected it would appear that in the locality mentioned the tendency towards the condition of dioecism has reached an advanced stage.—Mr. North exhibited the skin of a fledgling fan-tailed cuckoo, *Cacomantis flabelliformis*, which he had caught on October 3 in a gully at Chatswood. It was being fed by its foster parents, a pair of rock warblers, *Origma rubricata*, whose nest was found in a dark recess in the rocks a few feet away. Usually the egg or young of this parasite is found in domed nests built in situations which are more or less exposed to the

sun's rays. That it is not a solitary instance of this cuckoo depositing its egg in the nest of this gloom-loving species is borne out by the fact that the same pair of rock warblers built again in a rocky chamber about two hundred yards away from their previous nesting site

DIARY OF SOCIETIES.

THURSDAY, December 8.

Royal Society, at 4.30.—Effects of Prolonged Heating on the Magnetic Properties of Iron: S R. Roget.—On the Topographical Anatomy of the Abdominal Viscera, especially the Gastro-intestinal Canal: Prof. Addison.—Mathematical Contributions to the Theory of Evolution. VI. Reproductive Selection. Part I. Theoretical: Prof. Pearson. Part II. On the Inheritance of Fertility in Man: Prof. Pearson and Miss Lee. Part III. On the Inheritance of Fecundity in Thoroughbred Racehorses: Prof. Pearson, with assistance of L. B. Moore.—Nitragin and the Nodules of Leguminous Plants: Miss Maria Dawson

Mathematical Society, at 8.—On Groups of the Order $p^a q^\beta$: Prof. Burnside, F.R.S.—On Simultaneous Partial Differential Equations: J. E. Campbell.

Institution of Electrical Engineers, at 8.—Improvement in Magnetic Space Telegraphy: Prof. Oliver Lodge, F.R.S.——And, if time permit: Telegraphy by Magnetic Induction: Sydney Everard.

FRIDAY, December 9.

Physical Society, at 5.—Longitudinal Vibrations in Solid and Hollow Cylinders; Dr. C. Chree, F.R.S.—On the Thermal Properties of Normal Pentane: J. Rose-Innes and Dr. Sydney Young F.R.S.

Royal Astronomical Society, at 8.—The Division Errors of the Greenwich Transit-Circle: F. W. Dyson and W. G. Thackeray.—On a New Instrument for Measuring Astrophotographic Plates: Dr. David Gill.—Observations of the Leonids 1898 November, made at Cambridge Observatory: A. R. Hinks.—Note on the Effect of Wear on the Errors of Micrometer Screws: Dr. David Gill.—On a Probable Instance of Periodically-Recurrent Disturbances on the Surface of Jupiter: W. F. Denning.—Observations of Comet Coddington (*c* 1898): John Tebbutt. The Extra-Equatorial Currents of Jupiter during the Apparition of 1897–98. Rev. T. E. R. Phillips.

Malacological Society, at 8.—Notes on a Third Collection of Marine Shells from the Andaman Islands, with Descriptions of New Species of *Mitra*: J. Cosmo Melvill and E. R. Sykes.—Description of Three New Species of Marine Shells from N.W. Australia: Edgar A. Smith.—The Melaniidae, a Heterogeneous Family: J. E. S. Moore.—On the Affinities of *Donovania* (*Lachesis*) *minima*: M. F. Woodward.

MONDAY, December 12.

Society of Arts, at 8.—Acetylene: Prof. Vivian B. Lewes.

Royal Geographical Society, at 8.30.—Exploration in the Caroline Islands: F. W. Christian.

TUESDAY, December 13.

Zoological Society, at 8.30.—On the Cerebral Convolutions of the Gorilla: F. E. Beddard, F.R.S. On certain Characters of Reproduced Appendages in Arthropoda, and particularly in the *Blattidae*: H. H. Brindley.—Contributions to the Osteology of Birds. Part II. Impennes: W. P. Pycraft.

Institution of Civil Engineers, at 8.—Paper to be discussed: The Ventilation of Tunnels and Buildings: Francis Fox.

Royal Statistical Society, at 5.30.

WEDNESDAY, December 14.

Society of Arts, at 8.—Commercial Education: Sir Albert Rollit.

THURSDAY, December 15.

Royal Society, at 4.30.—*Probable Papers:* On the Reciprocal Innervation of Antagonistic Muscles. Fifth Note: Prof Sherrington, F.R.S.—The Action of Magnetised Electrodes upon Electrical Discharge Phenomena in Rarefied Gases. Preliminary Note: C. E. S Phillips.—Observations on the Anatomy, Physiology, and Degenerations of the Nervous System of the Bird: Prof. Rubert Boyce and Dr. W. B. Warrington.—Note on the Densities of Atmospheric Nitrogen, Pure Nitrogen, and Argon: Prof. W. Ramsay, F.R.S.

Linnean Society, at 8. Sketch of the Zoology and Botany of the Altai Mountains: H. J. Elwes, F.R.S.—A Description of some Marine and Freshwater Crustacea from Franz Josef Land, collected by W. S. Bruce, of the Jackson-Harmsworth Expedition: Thos. Scott.

Institution of Electrical Enginreers, at 8.

Chemical Society, at 8.—The Interaction of Ethylic Sodiomalonate and Mesityl Oxide: Dr. A. W. Crossley.—Derivatives of Camphoric Acid, Part III.: Dr. F. S. Kipping, F.R.S. Synthesis of $a\beta\beta$ Trimethylglutaric Acid: H. Perkin, jun., F.R.S., and Dr. J. F. Thorpe.

FRIDAY, December 16.

Institution of Civil Engineers, at 8.—The Kentish Town Widening, Midland Railway: Walter Daniel.

Quekett Microscopical Club, at 8.

BOOKS, PAMPHLET, SERIALS, &c., RECEIVED.

Books.—The Tutorial Algebra: W. Briggs and G. H. Bryan, Part 2 (Clive).—Elementary Botany: Prof. G. F. Atkinson (New York, Holt).—Through New Guinea and other Cannibal Countries: H. Cayley-Webster (Unwin).—Flora Capensis, Vol. vi. (Reeve).—Flora of Tropical Africa, Vol. vii. (Reeve).—Geological Survey of Canada, Annual Report (new series), Vol. ix., 1896 (Ottawa, Dawson).—Physical Chemistry for Beginners Dr. van Deventer, translated by Dr. R. A. Lehfeldt (Arnold).—My Horse; my Love: S. Buckman-Linard (Unwin).—Matter, Energy, Force and Work (Prof. S. W. Holman (Macmillan).—Prismatic and Diffraction Spectra: J. von Fraunhofer (Harper).—The Free Expansion of Gases; Gay-Lussac, Joule and Thomson (Harper).

Pamphlet.—Chemische Technologie, &c.: Dr. F. Fischer (Braunschweig, Vieweg).

Serials.—Bulletin of the American Mathematical Society, November (New York, Macmillan).—Encyklopädie der Mathematischen-Wissenschaften, Band 1, Heft 1 (Leipzig, Teubner).—Journal of the Asiatic Society of Bengal, Vol lxvii Parts 170, 171 and 173 (Calcutta).—Proceedings of the Royal Society of Edinburgh, Vol. xxii. No 2, Pp. 137–248 (Edinburgh).—Zoologist, November (West).—American Naturalist, November (Ginn).—Transactions of the Academy of Science of St. Louis, Vol vii. Nos 17 to 20 (St. Louis).—Agricultural Gazette of New South Wales, September (Sydney).—Bulletin de la Société Impériale des Naturalistes de Moscou, 1898, No. 1 (Moscou).—Monthly Weather Review, October (Washington).—Longman's Magazine, December (Longmans).—Chambers's Journal, December (Chambers).—Good Words, December and Christmas (Isbister).—Sunday Magazine, December and Christmas (Isbister).—Bulletin of the Liverpool Museums, October (Liverpool).—Contemporary Review, December (Isbister).—Astrophysical Journal, November (Chicago).—Natural Science, December (Dent).—National Review, December (Arnold).—Fortnightly Review, December (Chapman).—Scribner's Magazine, December (Low).—Photogram, December (Dawbarn).—Kew Bulletin, Additional Series, ii. (Eyre).—Century Magazine, December (Macmillan).—Humanitarian, December (Duckworth).—Zeitschrift für Physikalische Chemie, xxvii. Band, 3 Heft (Leipzig).—L'Anthropologie, tome ix. No. 5 (Paris).—Knowledge, December (Witherby).

Bacon's Chart of Common Poisonous Plants (Bacon).

CONTENTS.

THURSDAY, DECEMBER 15, 1898.

HINDU MANNERS AND CUSTOMS.

Hindu Manners, Customs and Ceremonies. By the Abbé J. A. Dubois. Translated from the Author's later French MS., and edited with notes, corrections, and biography by Henry K. Beauchamp. With a Prefatory Note by the Right Hon. F. Max Müller, and a Portrait. Pp. xxxvi + 730. (Oxford: at the Clarendon Press, 1897.)

THE work of the Abbé Dubois, both in the original French, and in the English editions—the one published in 1816, the other some thirty odd years ago—has long been a standard work on modern Indian customs, much valued and frequently quoted by ethnologists. But strange to say, what has hitherto been known as the Abbé's work is in fact merely a rough sketch and (as Mr. Beauchamp says) "only an extremely poor representation of what the Abbé's great work really was." The history of the book is peculiar. The French MS. of the original draft was placed in the hands of Major Wilks in the year 1806, when the Abbé had been about fourteen years in India. Major Wilks studied the work, and on his recommendation the MS. was, in 1807, purchased by the Madras Government and transmitted to London for translation and publication. Yet the English translation was not published until 1816. In 1815 the MS. was returned to the Abbé, and he "put into it all the additions and corrections suggested by many years of additional study and investigation; and when he sent it back to the Government of Madras, it was, practically speaking, a different work altogether." However, neither this revised MS., nor a finally corrected copy prepared by the Abbé three years later, have ever been used for the editions hitherto published, although both MSS. were sent to England and preserved in the India Office Library. One copy of the finally revised MS. was left in the records of Fort St. George, and this has now been translated and edited by Mr. Beauchamp, so that at last we possess the Abbé's work in its final and corrected shape.

The work of the Abbé Dubois is vastly superior to the ordinary accounts of travellers and missionaries in India. Few Europeans have succeeded in obtaining so much valuable information concerning the life of the natives as the Abbé. The secret of his success is best told in his own words (p. 10):

> "I had no sooner arrived amongst the natives of India than I recognised the absolute necessity of gaining their confidence. Accordingly I made it my constant rule to live as they did. I adopted their style of clothing, and I studied their customs and methods of life in order to be exactly like them. I even went so far as to avoid any display of repugnance to the majority of their peculiar prejudices. By such circumspect conduct I was able to ensure a free and hearty welcome from people of all castes and conditions, and was often favoured of their own accord with the most curious and interesting particulars about themselves."

That he went about in this way, and identified himself, as it were, with the people, makes the Abbé's account of Hindu manners, customs, and ceremonies so very valuable even in the imperfect form in which it has been known for years, and of course all the more valuable in its final and corrected form as presented to us by Mr. Beauchamp. Times have changed, no doubt, since the days when Abbé Dubois wrote. But Mr. Beauchamp is certainly right in saying that the work is "as valuable to-day as ever it was; even more valuable in some respects." For although the Abbé's work is merely an account of the inner life of the Hindus as seen and studied by him at the beginning of this century and in a limited area, viz. the country that lies south of the Vindhyan range, yet the broad facts of Hindu religion and sociology, as recited by the Abbé, are to a great extent true for a much wider area, and they are extremely instructive when compared with the facts known from ancient Hindu literature on the one hand, and with the manners and customs of the present day on the other.

Mr. Beauchamp has added some very valuable notes which go far to prove that the Hindu character is not quite as unprogressive as it is generally imagined to be, that even in India civilisation is not at a standstill, but that some progress has been made even within the short space of seventy or eighty years. On the other hand, if we compare the Abbé's account of Hindu life with what we know from ancient Hindu literature (and our knowledge of *ancient* Hindu life has become infinitely more accurate and comprehensive than it was when the Abbé wrote), we are constantly startled by the tenacity with which ancient customs survive in India. And for this very reason the Abbé's description is of inestimable value for the student of ancient India.

The most valuable parts of the book are those in which the author relates what he has seen himself. The Abbé is a shrewd and patient observer, and his account is full of the most interesting information about caste divisions, religious ceremonies and superstitions, about witchcraft, social customs, especially marriage rites (pp. 214–235), burial and mourning customs (pp. 321 *sq.*; 354 *sqq.*; 488 *sqq.*), about the status of women (pp. 315 *sqq.*, 339–370, &c.), infanticide, customary law, snake worship, cattle worship, &c. The Abbé has even a vague idea of what is now called comparative mythology (*cf.* p. 550 *sqq.*).

But what he relates, not from his own observation, but from literary documents (written in Sanskrit or Tamil), must be used with great caution, and should be compared with more recent and authentic publications, such as the works on Hindu law and ritual translated in the "Sacred Books of the East." The books from which the Abbé derives his information are mostly modern compilations of a sectarian character. Thus, the "Nittia-Karma" (rather "Nityakarma"), from which the author quotes largely (p. 238 *sqq.*), is evidently a text of the Vaishnava sect, and many of its details would not be applicable to members of other sects.

It must also be borne in mind that the Abbé is a Christian missionary, and his judgment is by no means unbiased. His strictures on the Hindu character are certainly most unfair, and his wholesale condemnation of the Brahmans as a class cannot be accepted by any serious student. Our acquaintance with the history of civilisation in India enables us to gain a far more favourable view, both of the moral and intellectual development of the Hindu nation. To quote only one example. What the Abbé says (p. 380 *sqq.*) about the learning of the

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Brahmans, contending that they have not systematically cultivated learning, and that they have not made any appreciable progress in its pursuit, is absolutely false in the light of our present knowledge of Sanskrit literature. A mass of scientific literature (on grammar, astronomy, medicine, philosophy) is there to contradict such a statement.

The Abbé's knowledge of Buddhism is derived from very secondary sources—evidently from accounts given by the most passionate opponents of the Buddhists. Hence he speaks of "this odious doctrine" of "pure materialism," and of "this abominable school" (p. 415) with utter contempt. Had he known Buddhism from its own literature, and been able to acquaint himself with Buddhist ethics, or had he known only the older and purer Sanskrit literature (which, indeed, in his days was scarcely accessible), his judgment of the moral character of the Hindus would probably have been less partial, and his picture of the Hindus as a nation would have shown brighter features than is the case now.

The editor and translator has performed his task very creditably. We should only have wished that the Sanskrit quotations had been given in a more correct form, and a more modern spelling of the Sankrit names and terms substituted for the spelling used by the Abbé. The index (of six pages to 724 pages of text!) is rather too meagre for a work of such an extent, and treating on such a variety of subjects. But these are minor faults in a work for which every Indologist and Ethnologist will be thankful.

M. WINTERNITZ.

FOSSIL PLANTS.

Fossil Plants for Students of Botany and Geology. By A. C. Seward, M.A., F.R.S., F.G.S. Vol. i. Pp. xviii + 452. (Cambridge University Press, 1898.)

THE botanical side of palaeontology has been passed over in general treatises and text-books in a manner that shows the authors had little, if any, personal knowledge of fossil plants. This has been due to the want of any trustworthy elementary manual on the subject. Mr. Seward's admirable book, of which only the first volume is published, will supply this want. Though addressed to students of botany and geology, it must be regarded mainly as a guide to palaeobotany for the benefit of the former, since no one not well versed in botany could follow the technical descriptions of such structures, for examples as the Calamites. On the other hand, introductory chapters on geology and the conditions under which fossil plants are preserved, enable the botanical student to read the book with no previous study of geology.

Mr. Seward, while not going so far as the late Prof. Williamson, who would diagnose no fossil plant which did not exhibit internal structure, lays great stress on the pitfalls in the way of those who have to determine fossil plants in which no structure is preserved. The group of jointed stems on p. 95, belonging to Cryptogams, Gymnosperms, Monocotyledons and Dicotyledons, is scarcely a happy illustration of the danger of trusting to superficial resemblances, since hardly any one at the present day would be likely to base determinations on such material without collateral evidence. In collecting and studying fossil floras, if these are at all extensive, it is easy to perceive whether they are from damp or dry statior from temperate or warm climates, and so on; and suc considerations would materially help in ascertainin whether Equisetum or Casuarina and Ephedra would l likely to be present. The worker, however, is rare obliged to rely on isolated leaves or twigs, and an e amination of the matted masses in which Equisetum usually fossilised, is convincing as to the real nature the plants. In dealing with late Cretaceous and Tertiar plants it may be well to remember that continental floras now held to be indigenous to certain regions, have for merly been migratory over wide areas, and are probabl now but sojourners on the spots they occupy. The gener composing them were associated together in the pas much as they are now, a fact that may assist in thei determination. Floras of oceanic islands have probabl been indigenous from remote periods, as with the Tertiar plants of Madeira, which comprised few exotics.

Palaeontologists may hardly agree as to the propriet of adding the terminations "ites" or "opsis" to recen genera when they have been proved to have existed i the fossil state, unless the nomenclature of plants is t differ from that of animals, otherwise we should hav Nautilites, Terebratulites, Ostreites. Such termination are more useful when implying doubt as to the actua identity of the recent and fossil genera. These, how ever, are minor matters, and the introductory chapter are on the whole so lucid and sufficient, presenting al requisite information in so concise and reasonable a manner, that there is little room for criticism.

Almost 300 pages of the first volume are devoted to the "systematic" description of fossil plants, beginning at the lowest and leaving off in the midst of vascular cryptogams. The lowest forms of plant life, unless partly siliceous or calcareous, are rarely preserved, and are of little interest to the geologist or palaeontologist. The completeness with which even the largest seaweeds decay, especially the brown algae, leaves little hope that many can have been preserved; and there can only be one opinion as to the wisdom of discarding all problematical markings. The ancient and gigantic Nematophycus is almost the only one determined with certainty. It was remotely allied to Laminaria, and is met with in Silurian and Devonian rocks. The Diatoms, so far, do not appear to be more ancient than the Lias. The Siphoneae are a group of exceptional palaeontological interest, and though most of the Caulerpites of old authors are passed over, the minute and often beautiful calcareous organisms so familiar to collectors of Eocene mollusca receive adequate attention. The very ancient Corallinaceae, the plant nature of many of which has only recently been admitted, are fully dealt with, and the extensive part they are now known to have played as reef-builders is recognised. The Characeae form a distinct group, the Charophyta, the fruits of Chara, so abundant in the Eocenes, first definitely appearing in the Jurassics, if not indeed in Palaeozoic rocks.

The fossil Hepaticae are of little interest, being so poorly represented in the fossil state, and of those recorded the author scarcely accepts any except the Marchantites of Sezanne and some of the fragments preserved in amber. Though it seems so probable that mosses must have been well represented in carboniferous

forests, no unmistakable specimen of that date has yet been discovered.

The concluding chapters are devoted to vascular cryptogams, over 140 pages being assigned to the Equisetales, chiefly to the remarkable group of Calamites, which must have been so conspicuous an element of carboniferous vegetation. Though cryptogamic, they formed large trees forty or fifty feet high, with woody trunks of exogenous growth. For this reason a section of the Calamites named Camelodendron have been and are even yet regarded as Gymnosperms by some French writers. The genera and species of this group are peculiarly difficult to diagnose, every organ being detached and preserved in a different manner. Internal casts of pith cavities in sandstone are the most familiar objects, but the more valuable specimens are those which preserve their internal structure, so ably deciphered by Williamson and others. The foliary organs are found separately in the shales and ironstone nodules; and the strobili in various conditions, which have permitted their internal and external structure to be examined. The roots of several kinds are also found detached from the stems. The author, without attempting to unite these scattered organs into specific wholes, has grouped the facts in the clearest manner. The variety presented prove that several distinct generic types existed, and as each variety of each separate organ was first described in ignorance of its probable relationship to the other, a complicated nomenclature has resulted. The Calamites, well represented in the Devonian, did not survive the Permian, though represented in the newer rocks by the closely related Equisetum.

The second important carboniferous group, Sphenophyllum, is also placed in a separate class, the Sphenophyllales, as a type that cannot be assigned to any existing group. Its leaves are wedge-shaped, with one or several veins and disposed in whorls, the strobili long and narrow, and the stem slender and woody. It was possibly a climbing plant, and is regarded as linking the Calamites and Lycopods.

In so brief a notice it is difficult to do justice to a work so full of matter and observation. Botanists and geologists must equally congratulate themselves on having so obscure and difficult a subject put before them for the first time in a really lucid and comprehensive manner.

J. S. G.

INFINITESIMAL CALCULUS.

Infinitesimal Analysis. By William Benjamin Smith. Vol. i. Pp. xvi + 352. (London: Macmillan and Co., Ltd., 1898.)

IT may be assumed that the contents of this volume represent, on the whole, the author's conception of a reasonable first course for the average University student. Judged from this point of view, the work certainly deserves approval, and is a favourable specimen of the class to which it belongs.

In the first two chapters the processes of differentiation and integration are explained, with appropriate graphical illustrations. No attempt is made to discuss all the subtleties which modern function-theory has shown to be involved in the assumption of the possibility of differentiation and integration, but the analysis, so far as it goes, is sound, and something is done to guard the student from making false generalisations.

The next four chapters deal mainly with applications. These have been judiciously selected, and are of practical importance as well as theoretical interest. Kinematical applications might have been advantageously included; in fact, considering the general character of the book, it is strange that kinematical considerations have been almost entirely ignored.

Chapter vii., on partial integration, concludes with Green's theorem; it is a pity that Stokes's theorem was not also included. A short but useful chapter on definite integrals, and another on curve-tracing, conclude the volume.

On pp. 18–20 there are some remarks about velocity with which we profoundly disagree. After allowing that "according to the most familiar notions" $\Delta s/\Delta t$ "is the *average speed* (or velocity) during the time Δt," and that "if the space be a function of the time" (it is difficult to see how any other assumption could be made) then in general $\Delta s/\Delta t$ has a definite limit ds/dt when Δt becomes infinitesimal, Prof. Smith proceeds:

> "Mechanically, however, this limit is not itself an average speed at all, it is not of the same nature as the variable difference-quotient $\Delta s/\Delta t$. For this quotient *never* assumes this limiting value, no matter how small Δt be made. And this is quite what we should expect and what the nature of the case demands. For motion implies duration, however small, of time, and change, however small, of place. When there is no lapse of time and no displacement there is no motion, and hence no speed (or velocity). In all strictness, there can be *no motion at an instant* and hence no *speed* (or velocity) *at* an instant. The concept of speed (or velocity) or motion will not combine with the concept of instant (or point of time) to form a compound concept."

Surely Prof Smith has here confounded the concepts of motion and displacement. If we allow that motion at an instant is impossible, how are we to escape Zeno's paradoxical conclusion that all motion is impossible? How can I move from one place to another during a minute, say, if *at every instant* of that interval motion is impossible? The remark, later on, that "this limit of the average velocity, characterises not the action but the state of the body, and is itself *not* a velocity though everywhere named so," does not improve matters, and is really irrelevant. The definition of velocity is quite independent of such question-begging terms as "action" and "state." Each of these terms, as applied to velocity, is just as good and just as bad as the other: it is when we add the words "of the body" that the metaphysical difficulty comes in, on account of the relativity of motion. But assuming that we can form a clear concept of a continuous displacement expressed by a law $s = f(t)$, there is neither a logical nor a metaphysical difficulty in proceeding to $\dot{s} = f'(t)$ and saying that this is the velocity at time t, if we have already agreed that when $s = at + b$, the velocity is a (a, b being constants): that is, in whatever sense a measures the velocity for the law $s = at + b$, then *in precisely the same sense* $f'(t)$ measures the velocity at time t for the law $s = f(t)$.

Another passage to which we feel bound to call

attention is example 18, p. 229. Here the analysis really solves the problem of finding when $(\alpha+1)(\beta+1)\ldots(\lambda+1)$ is a maximum subject to the condition that $a^\alpha b^\beta \ldots l^\lambda = N$; $a, b, \ldots l$, N being given quantities. But the heading of the article is, "How must the prime factors of a number enter into it that it may have as many divisors as possible? (Waring)," a question from which we have vainly tried to extract any meaning whatever, and with which, in any case, Prof. Smith's analysis cannot have anything to do. G. B. M.

OUR BOOK SHELF.

Die Optik der elektrischen Schwingungen. (Experimental Investigations on Electro-magnetic Analogies of the most important Optical Phenomena.) By Prof. A. Righi. Translated into German, with additions by the author, by B. Dessau. Pp. xi + 267; with 40 illustrations and figures. (Leipzig: O. R. Reisland, 1898.)

THOSE to whom Prof. Righi's Italian edition of last year was not accessible, will welcome this German translation of his interesting book. The reproduction, by means of electro-magnetic waves, of some of the more complex optical phenomena, necessitates the use of an oscillator which gives out a series of waves that do not decrease too rapidly in intensity, and that are considerably shorter than those used by Hertz in his experiments.

Prof. Righi has carried on a number of investigations with such oscillators which emitted waves ranging upwards from 2·6 cms. in length, and the present volume is devoted for the most part to an account of this work.

The first part deals with a detailed account of the construction and use of his oscillators and resonators, and with the secondary waves due to the presence of the receiver and neighbouring bodies. These effects are studied first, in order that they may not lead to misinterpretations in the later results.

In the second part the electro-magnetic analogies of many optical phenomena are considered.

The working details of the experiments are given, and the difficulties attending them are pointed out, thus enabling one to reproduce the effects with the least amount of trouble.

Two investigations which have appeared since the publication of the Italian edition are then appended, and the last part of the book consists of mathematical additions on various topics connected with the subject in hand.

The book is written in an able manner, and conveys to the reader a clear idea of the properties of electrical waves, and Prof. Righi's method of manipulating them.

J. Z.

Calculations in Hydraulic Engineering. By T. Claxton Fidler, M.Inst.C.E., Professor of Engineering, University College, Dundee. Part i. Pp. xii + 155. (London: Longmans, Green, and Co., 1898.)

THIS is the first part of an extended treatise, and it discusses Fluid Pressure and the Calculation of its Effect in Engineering Structures. The treatment of the subject is refreshing and stimulating, by contrast with the arid methods of our scholastic text-books. The illustrations of the abstract theory are taken from actual problems on a large scale, which appeal to the engineering student, to whom this treatise is addressed. A striking novelty is the discussion in Chapters iv. and vi. of the buckling tendency in straight pipes under uniform fluid pressure. Although the material of the pipe carries no longitudinal thrust, the conditions of stability are exactly the same as in Euler's theory of the bending of a column. This paradoxical fact is discussed theoretically, and its experimental verification is described in an Appendix. Chapter v. is on Fluid Arches, and shows how the pressure in a main, forming a tubular arch, can be used to assist the stability. We are reminded of Prof. Fitzgerald's suggestions of inflated structures and columns, and the pneumatic system of architecture, in which the strength is kept up by compressed air, pumped in at intervals as required, as in the tires of our bicycles. A short account of Prof. Fitzgerald's theory will be found in the recent edition of Perry's "Applied Mechanics." Chapters viii. and ix. treat of the equilibrium and stability and bending stresses of floating bodies, not from the point of view of the Naval Architect, but as required by the Civil Engineer in the design of pontoons, bridge-caissons, and gas-holders.

The diagrams are carefully drawn to represent some real actual construction, and the illustrative examples are worked out to their numerical conclusions, an essential part of the theory for the engineering student, although so completely ignored in our academic treatises. G.

Birds of the British Isles. By John Duncan. Pp. xvi + 448; illustrated. (London and Newcastle: Walter Scott, Ltd., 1898.)

THE excellent illustrations and brief descriptions of British birds published in the *Newcastle Weekly Chronicle* met with such a favourable reception, that the author has considered it advisable to reproduce them in book-form. And in their new guise they form a volume which can scarcely fail to be acceptable to readers with limited purses, since, while every species is figured, the published price of the work is only five shillings. Neither can it be said that the volume is "cheap and nasty"; the type being clear and good, and the illustrations for the most part of high merit. Perhaps, indeed, they lack the pictorial elegance of photogravures, but as good specimens of wood-engraving they leave little to be desired; and there are many reasons why that style of illustration should not disappear from works of natural history. In many respects Mr. Duncan appears to be a disciple of Bewick; and in the case of the cuckoo (p. 142) so closely has he followed his master that his figure is merely a reversed replica of the original cut, with some additional details of surroundings. Generally, however, the figures are original, and they are often in advance of those of Bewick.

Although brief, the descriptions appear sufficient to identify the species. In the introduction, by Mr. C. Dixon, criticism of the work from a literary standpoint is deprecated; but the author might have ascertained that the British Isles form part of the Palaearctic region (p. 191), and also that the word *palaios* contains four vowels. As a whole, the volume is a highly creditable and artistic production. R. L.

Railway "Block" Signalling. By James Pigg, A.I.E.E. Pp. 387. (London: Biggs and Co.)

THIS account of the development and details of the "block" system of railway signalling brings together a large amount of interesting information upon a method of regulating railway traffic which has assisted very considerably in bringing about the present state of precision and safety in railway work. The system has been in use for about thirty years, and it now represents the most extensive of all the adaptations of electricity to railway work. Mr. Pigg describes clearly the principles of train signalling and the apparatus employed; he also includes in his work the codes, regulations, and rules relating to railway signals of various kinds. With regard to the lines along which developments will probably be made he remarks: "Railway signalling appears to have now reached a stage at which some departure from the present methods seems probable. The lines upon which changes will be made will, in all probability, result in a greater degree of automatic control than obtains at present."

The volume is an instructive contribution to an important subject.

The Story of Geographical Discovery. By Joseph Jacobs. Pp. vi + 224. (London: George Newnes, Ltd., 1899.)

MR. JACOBS has written a very readable little book. The historical aspect of geographical discovery is interestingly dealt with, and many subjects not usually included in books of geography are rightly given considerable prominence. The text is illustrated with twenty-four helpful maps, which serve to show the gradual increase of knowledge of our globe. The concluding table, showing the progress of geographical science from the time of Anaximander of Miletus down to the voyage of the *Challenger*, is most instructive. The author has collected his material with discrimination, and has evidently devoted much time and care to the preparation of his inspiring little volume. The recent marked development of imperial instincts should ensure the book the popularity it merits.

The Sphere of Science: a Study of the Nature and Method of Scientific Investigation. By F. S. Hoffman, Ph.D. Pp. viii + 268. (New York and London: G. P. Putnam's Sons, 1898.)

THIS book is the outcome of a series of lectures recently given by the author to his classes in Union College, to supplement their work in formal logic. Its object is to make clear what constitutes a science, and the grounds upon which every science must rest.

Very naturally, an important place is given to such considerations as the aims of science, what science takes for granted, the scientific method, and the limitations of science. Dr. Hoffman is always readable, and his style is pleasing. The book is by no means only a text-book; it will be found interesting by many educated readers, and should prove particularly useful in providing students of science with a knowledge of the groundwork of scientific investigation.

Chloroform: its Absolutely Safe Administration. By Robert Bell, M.D. Pp. 40. (Glasgow: R. L. Holmes, 1898.)

DR. BELL states the results of over thirty years' experience in the administration of chloroform. He writes "as one having authority," since he has no death to record from the use of chloroform throughout this long practice. It is maintained that when properly administered, there is absolutely no danger attending the use of chloroform as an anaesthetic; and Dr. Bell gives a large amount of evidence in support of his contention.

A Middle Algebra. By William Briggs, M.A., and G. H. Bryan, Sc.D., F.R.S. Pp. vi + 354. (London: W. B. Clive.)

IN this volume a knowledge of the more elementary properties of quadratic equations and progressions is assumed, and the requirements of candidates for the intermediate examinations for degrees at the University of London are especially borne in mind. Prof. Bryan's name is a guarantee for the accuracy of the book; and the arrangement, printing, and general appearance leave little to be desired.

Primer of Geometry. By James Sutherland, M.A. Pp. 117. (London: Longmans, Green, and Co., 1898.)

MANY of the early propositions in Euclid's First Book are reduced to actual measurements in this volume, and are thus brought within the ready grasp of the mind of the average boy. The book really teaches the rudiments of geometry and mensuration upon Fröbelian principles. Where the exercises it contains can be carried out, some of them will prove of educational value; but others are misleading.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Syrian Fishes with Abnormal Eyes.

NEAR the town of Hasbeya, Syria, arise springs which constitute in part the source of the small Hasbany river. In a short stream formed by those waters, I have found several varieties of abnormal-eyed fish, which, for convenience, may be grouped under five heads.

Fishes with (1) large protruding eyes; (2) an eye normal, and the other large and protruding; (3) half-protruding eyes; (4) two abnormal eyes unequal in size and development; (5) one eye normal, and the other rudimentary. At less than a hundred feet from the above-mentioned stream are two caves, but, strangely enough, only normal-eyed fishes could be found in the waters adjacent. The abnormal fishes are restricted to that stream, and are in the ratio of about one to four to the normal ones. The water is cold and tolerably clear, shallow near one bank and gradually deepening towards the other, to a depth not exceeding 7 feet in summer. No kingfishers or other fish-catchers were observed. Some of the fishes belonging to No. 1 had dark bodies and dark eyes, and seemed from their mode of motion to be little, if at all, sensible to light. Others belonging to No. 2 showed, by introducing a foreign object now near the normal eye and now near the abnormal one, that the latter saw less than the former. Dr. William van Dyck and Prof. A. E. Day, of the American College in Beirût, saw the fishes, and agreed that they had not met with any of the like during their study of the fauna of Syria. I may state that, having a small quantity of specimens, I would very willingly put it at the disposal of any specialist who may be interested in the question.

SALEEM MAKARIUS.

Al-Mokattam, Cairo, December 2.

Birds and Poisonous Fruit.

IT is naturally difficult to obtain direct evidence as to how birds rid themselves of the indigestible parts of the fruit they eat. It is a question to which I have given some attention from its bearing on the dispersal of seeds. I have found large quantities of the seeds of hawthorn, dog-rose, mistletoe, and ivy evidently voided by birds, as I incline to think generally as fæces, especially in the case of the hawthorn and ivy. Some large bird, I suppose the rook, consumes ivy berries largely in the spring, and gets rid of the seeds in what appears to be a mass of excrementitious matter. Many of these have not lost their vitality, and germinate readily in the same season. I have some thriving ivy plants obtained from such seed sown in 1896, and numerous seedlings this year of similar origin, the seed being sown on April 28, and coming up on June 7. I do not think much stress need be laid on the fact that much of the fruit swallowed is voided undigested, though the mistle-seeds I found were in a mass something like a lump of frog-spawn, with much of the pulp of the berry still adhering to each seed. I fancy birds and beasts, like many human beings, frequently swallow greedily far more than is good for them, especially when they light upon an abundant supply after enforced abstinence. An observant farmer informs me that horses coming in hungry to the manger will, if allowed, swallow corn more rapidly than they can digest it, if the grains are supplied whole, and that a large proportion passes in a condition to germinate. For this reason he has it crushed before given to them. I could supply Mr. Bennett or Mr. Lowe with some other curious evidence on this question if they care to have it, and will send their address.

Bedford. E. M. LANGLEY.

I CAN confirm Mr. Lowe's theory on this question.

For many years I have had robins coming to the hand for food in my garden. Before flying to the hand they constantly wait until they have succeeded in ejecting seeds from their crops. Great tits and blue tits also come to the hand, but never pause to eject anything. They are probably not large consumers of poisonous fruits.

I have on my lawn a large round china dish on an iron stand, in which many birds bathe, and from which they drink at all

hours of the day. I often see the bottom of this dish sprinkled with seeds, evidently ejected by the birds. At present they are the seeds of the Laurustinus (*Viburnum Tinus*).

Rosehill, Falmouth, November 29. Howard Fox.

Periodic Tides.

The letter of Mr. A. S. Thompson, in your issue of December 8, adds further interesting information as to secondary undulations, to that which I sent you in a paper printed in Nature of February 3 last. This paper appears to have escaped Mr. Thompson's attention, as in it he will find that this subject was investigated on the Swiss Lakes by Duillier in the middle of the last century, and by Vaucher in 1804. They found that these undulations are common to all lakes at intervals of about twenty minutes. More recently the subject was taken up by Mr. Napier Denison on the Great Lakes in Canada, where he found oscillations of three to four inches at intervals of from fourteen to eighteen minutes; and by Mr. Bell Dawson during the tidal survey of the Gulf of St. Lawrence, where he found regular minor undulations occurring, in addition to those due to the tides. W. H. Wheeler.

December 10.

Cristatella Mucedo.

As this very beautiful polyzoon is generally believed to be nearly, if not quite extinct in ponds in the neighbourhood of London, I should like to record the fact that on November 19 last, I took a fine specimen two inches in length, which is still living. The colony was packed with statoblasts, most of which are now discharged. It was not perfect when taken, and has again divided since it has been in a small aquarium.

Henry Scherren.

9 Cavendish Road, Harringay, N., December 3.

The Invention of the Gimbal.

Will you or some of your readers kindly inform me, when and by whom the construction of the gimbal was contrived for the first time? Kumagusu Minakata.

7 Effie Road, Walham Green, S.W.

THE VALUE OF EXERCISE.[1]

The value of exercise for the purpose of maintaining *mens sana in corpore sano* has been recognised from the remotest antiquity. Exercise, however, in its entirety seems to be divided into two sections which, though springing from the same cause, have led to different results: professional exercise or the training and maintaining of a body of athletes, and what may perhaps best receive the name of domestic exercise. The former appears to be one of the many instances of what was originally a means of becoming an end. Professional athletics doubtless took their origin in the use of exercise as a means; the perfect development of body and mind being the end. The huge muscles and small heads of professional athletes show us that the original means has finally become the end. This result from the point of view of the hygienist must be regarded as grotesque, and to the physician the professional athlete is neither more nor less interesting than the macrocephalic dwarf. The fainting and sickness of the over- or under-trained schoolboy, and the insomnia of the over-crammed student are essentially phenomena of the same class, and due to the same cause—viz. pathological plethora of some vascular areas, and pathological anæmia of others.

The use of exercise as a therapeutic agent, as also its use for the maintenance of health, falls under the second variety. The practice of exercises as part of one's toilette is very old. Any one conversant with the "heilgymnastik" (curative exercises) of the present day, let them belong to the systems of Ling, Schott, or Zander, cannot fail to be impressed with their resemblance to the devotional exercises of the devout Mahometan. Although doubtless the positions assumed by the worshipper are symbolical of passive submission, cringing obeisance, or subjected defiance, the point of interest to the physiologist is that after the performance of these devotions one experiences a distinct sense of fatigue. Thus by incorporating in his system of devotion actual muscular exercise the Prophet practically prescribed a system of "heilgymnastik," and forestalled the modern hygienic use of exercise. It would be interesting to know to what extent the exercise part of his devotions may be modified in the case of a Mohametan with *morbus cordis*. One fact, as will appear from the context, is worthy of notice. The devotional exercises are all performed slowly, and the change of posture is gradual. This is doubtless from a religious standpoint reverential, but from a physiological standpoint it prevents the occurrence of breathlessness or palpitation. In the one case which I had the opportunity of observing (devotion at sunset), the respirations were accelerated by four, the pulse by sixteen per minute by the devotions. This was in Algeria, near Hammam Rhira, at an altitude of 2000 feet. This effect might, no doubt, partially be due to psychical influences.

The modern therapeutic use of exercise is mainly directed to the attainment of two objects, local or general. The local use of exercises for the strengthening of certain groups of muscles mostly interests the surgeon or the neurologist. The ingenuity of Zander in inventing machines by which almost every group of muscles in the body can both be exercised, and made to do an exactly graduated amount of work, has done much to develope and systematise treatment in this branch of therapeutics. In the case of all muscles, including the heart, an optimal contraction is only obtained when the muscle contracts against an optimal resistance. This optimal resistance varies according to the condition of the muscle. In the case of the local use of exercise it is most important at the beginning of each set of exercises to find the optimal load. The great advantage of the mechanical system of resistance exercises, as compared with the manual method, is that once this optimal load is found it can be maintained constant, or as the condition of the muscle improves can be accurately increased. From this it follows that the work done on each occasion can be measured mathematically. It is impossible to achieve this by hand.

The second object aimed at by the therapeutic use of exercise is the one of most interest to the physician, viz. the production of a general systemic effect. This effect manifests itself chiefly upon the circulatory and respiratory systems. The sweating produced by exercise, although bringing into play the secretory function of the skin, and thus causing the excretion of certain noxious substances, as well as possibly the production and addition to the blood of an internal secretion, is essentially a circulatory phenomenon, and will not be further considered here, especially as exercise is, therapeutically, rarely pushed to such an extent as to produce sweating. One of the effects of exercise upon the respiratory system is known to every one, viz. breathlessness, or an increase in the depth and frequency of the respiratory movements. This dyspnœa varies according to the condition of the patient, and the amount or rather acuteness of the exercise. Physiologists are indebted to Zuntz and Geppert (*Pflüger's Archives*, xlii. p. 159) for having added most essentially to our knowledge of this condition. Before the work of these observers the dyspnœa attending exercise was held to be due to a diminution in the amount of oxygen and an increase in the amount of CO_2 in the blood; was, in short, regarded as an asphyxia. This hypothesis was based upon the experimental results of Mathieu and Urbain ("Du Gaz du Sang," *Archives de Phys.*, iv., 1871–72). Zuntz and Geppert, however, showed

[1] "Respiratory Exercise in the Treatment of Disease." By Harry Campbell, M.D., B.S., F.R.C.P. Pp. viii + 200. (London: Baillière, Tindall, and Cox, 1898.)

that during and immediately after exercise the amount of O in the blood was increased, and amount of CO_2 diminished as compared with their amounts at rest. They further concluded that during muscular exercise the contracting muscle poured into the blood substances the chemical nature of which was unknown, but which exerted a stimulating action on the medullary repiratory centre. In this phenomenon, according to them, neither pulmonary nor muscular centripetal nerves play any *rôle*. This latter dictum has been disputed by Filehne and Kionka (*Pfluger's Archives*, lxii. 96, p. 201), who hypothecate the existence of afferent nerves in the lung and muscles, which are sensitive to CO_2 production and are stimulated thereby. The main result of Zuntz and Geppert's work was not challenged by them, and still stands. In a later monograph Zuntz and Geppert maintain, and apparently correctly, their former work in its entirety.

This increased respiratory activity is within certain limits from a therapeutic standpoint a desideratum, as pulmonary resistance is thereby diminished, and the general circulation and flow of lymph accelerated.

In order to produce this salutary effect the respiration during exercise should be easy and full, and anything approaching effort, with its usual concomitant, closure of the glottis, should be avoided.

In this connection Dr. Campbell's recent book is interesting and useful. We cannot agree with the view expressed on p. 111, with regard to the causation of the dyspnœa attending exercise. The author at the close of his book gives a list of respiratory exercises calculated to attain certain ends. Dr. Campbell has produced an instructive and interesting monograph, and we shall be pleased to welcome his promised work on the mechanical treatment of heart disease.

Concerning the effect of muscular exercise upon the circulatory system, we have a very abundant literature to review, both physiological and medical. The recent development which this branch of therapeutics has taken, as exemplified by the thousands of visitors flocking to Nauheim, and the various mechanic, or manual gymnastic institutes, and the still larger numbers treated at their own homes, render the subject of considerable interest. The effects of the contraction of a muscle or group of muscles upon the circulation may be divided into local and general. The local effects, or the effect of its contraction upon the circulation through a muscle, was first investigated by Ludwig and his pupils, Sczelkow, Sadler and Gaskell. Some of Sadler's (*Ludwig's Arbeiten*, 1869, p. 77) results have a direct bearing upon resistance exercises as practised at the present day, since he studied the circulation through a group of muscles which were thrown into contraction, but were at the same time prevented from becoming shortened. He found that, as in the case of muscles contracting under ordinary circumstances, more blood passed through them than in the condition of rest. He also found that more blood passed through the contracting muscles when they were prevented from becoming shortened. than when they were allowed to do so.

Gaskell's (*Ludwig's Arbeiten*, 1877, p. 45) experiments showed that the maximum flow occurred either at the end of a long contraction (tetanus), or directly after the cessation of a contraction. In all these experiments the excitant was electric stimulation. In the case of exercise in the living animal the excitant is either volitional or reflex. The results, however, of Cheauveau and Kaufmann (*Archives de Phys.*, 1892, p. 279), who worked on the masseter of the horse during mastication, and in the main confirmed the above results, showed that the artificial nature of the excitant in Ludwig's experiments made no appreciable difference. Mosso[1] found that the volume of an arm as measured phlethysmographically increased immediately after contraction of the flexors. Some experiments I made conjointly with Dr. Lauder Brunton[1] showed that the amplitude of the pulsation of the arteries contained in the gastrocnemius increased considerably immediately after contraction of this muscle. The tracing showed that in addition to the arteries being dilated immediately after contraction they were relatively fuller of blood.

These results, obtained by different methods and by several observers, seem clearly to indicate that one of the local circulatory effects of muscular exercise is a dilatation of the vessels of the corresponding muscular area; or, in other words, a lessening of the resistance to the flow of blood through the muscles. In view of the relaxation of the antagonistic muscles which apparently accompanies the contraction of any group of muscles, it would be interesting to see what, if any, changes occur in the vessels of these relaxing muscles. If a dilatation occurs here also, as seems *à priori* probable, the vascular area affected would be considerably increased, and then the effect on the general circulation would be magnified.

If we turn from the local circulatory effects of muscular contraction to the effects produced on the general circulation by the contraction of a group of muscles, we shall find in the first place that a determining factor of the greatest importance is the amount of exercise; and this is best measured by the degree to which the respiration is affected. The results of former observers, Marey ("La Circulation du Sang," 1881, 343). Oertel,[2] von Basch, and others, have been entirely confirmed by those of more recent investigators, viz. Hallion and Comte (*C. R. Soc. de Biologie*, x. serie, iii. 906), Bloch, Mosso (Der Mensch auf den Hochalpen Leipsig, 1899), Brunton and myself (*loc. cit.*), Zuntz and Hagemann (*Deutsch Med. Woch*, 1892), Taugl and Zuntz (*Pfluger's Archiv.*, lxx. 544, 1898), and Kaufmann (*Archives de Phys.*, serie 5, t. iv. p. 493). Zuntz and his collaborators are evidently unaware of the work of Mosso and his pupils, and of Brunton's and my own paper.

The results of Zuntz and his collaborators showed that in the horse a gentle walk was accompanied by a fall in blood pressure amounting to about one-twelfth. In the case of dogs, gentle exercise was accompanied by a slight rise in blood pressure amounting to one-twelfth or one-tenth, whereas violent exercise rapidly caused a doubling of the blood pressure in the carotid. The experiments made in Mosso's laboratory on man, including those contained in Brunton's and my own paper, confirm the above results obtained upon animals. However gentle the exercise, an increase, sometimes very slight in blood pressure, occurs; this, however, sometimes during exercise, invariably after it, is followed by a fall, which continues for some time after the exercise has ceased. If the exercise is violent the accompanying rise in blood pressure is considerable one-sixth to one-eighth, and this high pressure is continued so long as the exercise lasts, the pressure gradually returning to its former level; this, in some cases, taking two hours or more. All observations upon the blood pressure in man directly after exercise more or less severe, which have been sufficiently numerous, confirm these results (see "Oertel," *loc. cit.*). These experiments are of interest from a therapeutic standpoint, in that they show that it is possible to obtain the beneficial effects of exercise at the expense of a very slight extra strain upon the heart.

A question at the present time of considerable interest is, how are the cardio-vascular results which follow exercise brought about? Are we to assume that they are central, and are produced by the action of substances of

[1] "Sulle Variazioni locali del polso nel ante-braccio del uomo." Torino, 1878.

[1] "Remarks on the effect of Resistance Exercises in Man, local and general." (*British Medical Journal*, October 16, 1897.)

[2] "Handbuch der allgemeiner Therapie der Kreislaufs Storungen." Leipzig, 1891.

unknown chemical nature, the products of muscular contraction, acting upon the medullary centres, or that they are reflex? In this latter case two hypotheses may be adopted—viz. that the afferent impulse is due to peripheral chemical, or peripheral mechanical stimulation. So far as I am aware no work has been done on the lines of Geppert and Zuntz (*loc. cit.*), or Filehne and Kionka (*Pfluger's Archives*, Bd. lxii, 201, 1896) with regard to the vascular effects of exercise. A paralysing action on motor nerve endings has been ascribed to the products of muscular activity, but to what extent the nerve endings in non-striped muscle are influenced by these products has not been shown. A further question of interest, which remains yet to be decided, is what are the vascular areas which become anæmic during exercise? The nausea or vomiting, which is the frequent accompaniment of violent exercise when one is in "bad condition," seems to point to the splanchnic area as the one at the expense of which the muscular plethora occurs; but, so far as I am aware, no phlethysmographic records of the abdominal organs during extensive muscular contraction have as yet been made.

In considering the effect of the contraction of a muscle upon the circulation through it, the muscular substance of the heart itself naturally comes into consideration. The circulation through the coronary arteries when these vessels have not lost their normal elasticity from atheroma or other causes, is unquestionably increased by full and frequent cardiac contraction, and the state of nutrition of the heart thereby improved. Further, increased pressure in the aorta within certain limits is advantageous to the coronary circulation. The experiments which have been made recently upon the excised mammalian heart (Langendorf, *Pfluger's Archives*, lxx., 1898, p. 473) tend to show that the conditions for optimal contraction—that is, for a maximum output of energy at each beat—are practically the same in the case of the mammalian as in that of the frog's heart (Tunnicliffe, *Journal of Phys.*, xx. 1, 96). Of these one of the most important is the choice of an optimal load, the cardiac muscle in this respect being similar to ordinary striped muscle. This, from a practical standpoint, amounts to the fact that although a heart can be, and of course very often is overloaded, or in other words is unable to meet the resistance which the normal circulation offers to its contraction, it can also be underloaded; that is, the cause of its insufficient contraction may be that not sufficient resistance is offered to its systole. This underloading of the heart may play an important *rôle* in sluggish circulations in women, and men living sedentary lives. Fairly severe but gradually commenced and gradually increased exercise in these individuals will often supply the necessary load, and bring back the cardiac action to the normal. It is the function of the physician to discriminate between the over- and under-loaded heart, and to treat it accordingly; exercise may find a place in each variety of this treatment.

In this paper nothing has been said with regard to another aspect of exercise from a therapeutic standpoint. We have discussed the possibility of certain chemical substances produced during the contraction of muscle exerting an action on the respiratory and cardio-vascular centres, but we have said nothing of the possible effect on general metabolism of such products or others accompanying them. That such an effect is produced is seen by the general nutritive results of local muscular exercise and of massage. Whether the physiological basis of such a result consists in the removal of waste products—that is, is essentially increased excretion—or in the production of substances which have an action allied to the internal secretion of glands, remains yet to be decided.

F. W. TUNNICLIFFE.

THE ZOOLOGICAL EXPLORATION OF THE GREAT AFRICAN LAKES.

OWING to the unique and extremely interesting nature of the fauna in Lake Tanganyika, the study of which was recently the object of an expedition supported by the Royal Society, and led by Mr. J. E. S. Moore, a Committee has been formed, consisting of Sir John Kirk, G.C.M.G., K.C.B., F.R.S. (late British Resident at Zanzibar), Dr. P. L. Sclater, F.R.S. (secretary to the Zoological Society), Mr. Thiselton-Dyer, C.M.G., F.R.S. (director of Kew Gardens), Prof. Ray Lankester, F.R.S. (director of the Natural History Departments of the British Museum), and Mr. G. A. Boulenger, F.R.S. (of the British Museum), for the purpose of organising another expedition to the same regions, to thoroughly survey the basin, not only of Lake Tanganyika, but also the unknown portions of the northern extension of the great series of valleys in which Tanganyika, together with Lakes Kivu and the Albert Nyanza, lie; to collect specimens of the aquatic fauna and flora, and to study the geological history of this part of Africa. The latter object of the investigation should be of especial interest, for it was shown by Mr. Moore that almost without exception the shells of the singular series of whelk-like molluscs, captured by him in Tanganyika, are indistinguishable from those now found fossilised in Europe, among the remains of old Jurassic seas. It would thus appear that at some remote period of time, the great valley of Tanganyika was in connection with the sea, and that the strangely isolated marine fauna, which still inhabits its slightly brackish waters, has remained there ever since. So far only the *Medusae* (jelly-fish), the *Mollusca*, and the *Crustacea*, belonging to this antique fauna, have been discovered in the lake; but when its vast size and depth are fully realised, it is unquestionable that by far the larger portion of its fauna is as yet unknown.

Tanganyika thus presents a unique field for scientific exploration at the present time, and is, indeed, one of the few places now left upon the earth where animals (like those peculiar to Australia) which have long since become extinct elsewhere, may still be found.

Another notable fact ascertained during Mr. Moore's last expedition, was that the marine, or *Halolimnic* fauna of Lake Tanganyika does not exist in either Nyassa or in Lakes Shirwa, Mwero, Bangweolo, or any of the remaining lakes about which anything zoological is known; but it may yet be found in Lakes Kivu, the Albert Edward and Albert Nyanzas, which lie, as has been said, in an extension of the same great depression which contains the Dead Sea towards the north. The probability of this being so, is also increased by the curious fact that the fauna of Tanganyika bears some resemblance to that of the lower portions of the Nile.

During the present expedition it is therefore intended to go north from Tanganyika, which will form the zoological headquarters of the expedition, through the unknown region which lies between Tanganyika and Lake Kivu, on, finally, to the Albert Edward and Rowenzori districts. It is intended then that the expedition shall pass eastward, through the Uganda stations north of the Victoria Nyanza, down the Uganda roads and railway to the sea. Mr. Moore's previous expedition was hampered by the unexpected difficulties of transport and the want of a steamer properly to carry on dredging and sounding operations in the lake, and, in consequence of this, much valuable material, particularly large specimens of entirely new species of fish, had to be deliberately left behind. At the present time, however, the African Lakes Corporation are running the London Missionary Society's old steamer once more upon the lake, and all these deficiencies can therefore now be overcome, provided the necessary funds are raised.

A careful consideration of the details of the expenditure has led the Committee to the conclusion that in order to enable Mr. Moore to successfully lead another expedition for two seasons, and to accomplish the above-stated objects, a sum of not less than 5000*l.* wtll be required. The Committee have already received encouraging offers of support, including one of 1000*l.* from a gentleman connected with the commercial and political interests of British Africa. They point out, however, that the results to be obtained will increase almost in the ratio of the square of the initial expenditure; and in a private circular, which has been issued, the members of the Committee appeal to those who feel interest in the objects of the expedition, for assistance in carrying out an enterprise which is not only of the highest scientific importance, but is also of great significance in securing British influence in a critical region of the African interior.

UNIVERSITY COLLEGE AND THE UNIVERSITY OF LONDON.

We are glad to be able to publish the following text of a resolution adopted by the Council of University College, London, at their session on December 10. The offer contained in the resolution is a noble one; and we hope that the example afforded by it will be followed by other similar institutions, in order that the labour of the Statutory Commission may be simplified.

That a Deputation be appointed to represent to the Statutory Commission that—inasmuch as

(1) University College, London, was founded as the University of London, with the object of providing a complete University education in London of the highest type.

(2) The intention of the founders and benefactors of University College will only be carried out by the incorporation of the College in the University, so that its resources shall still be utilised for the furtherance of the highest educational work and for research.

The Council are prepared to summon a general meeting of the members of the College, and to propose to them that such steps should be taken as may be necessaiy for placing the site, land, buildings and endowments of the College at the complete disposal of the reconstituted University.

In making this offer the Council do not desire to throw any obstacle in the way of any other institutions in London which may be disposed to place their resources at the disposal of the Governing Body of the University.

It will be necessary in accordance with the precedent afforded by the Universities Act (Oxford and Cambridge) to protect the interests of the existing teachers and executive staff of the College. The existing teachers are, however, to have no claim as such to any rank in the re-constituted University, or to any vested interest other than that they now have in the College.

Special provision will probably have to be made as to the boys' school and its endowments, and perhaps for appropriate buildings on another site being provided for this department of the College work. Arrangements will also have to be made with regard to the Hospital and its funds, of which the College is now the Trustee.

(Signed on behalf of the Council),
J. Gregory Foster,
Acting-Secretary.

NOTES.

Prof. Marsh has been elected a correspondant of the Section of Mineralogy of the Paris Academy of Sciences, in succession to the late Prof. James Hall.

The Geographical Society of Berlin (Gesellschaft für Erdkunde zu Berlin) have sent out a circular inviting the friends and promoters of geography in all countries, and especially the members of geographical societies and cognate scientific bodies, to be present at the seventh International Geographical Congress, to be held in the German capital from Thursday, September 28, to Wednesday, October 4, 1899. Before the beginning and after the close of the Congress, excursions will be arranged through such parts of Germany as are of interest from the points of view of physical or economic geography. The subjects which are to be discussed at the Congress will be arranged in the following groups: (1) mathematical geography, geodesy, cartography, geophysics; (2) physical geography (geomorphology, oceanology, climatology); (3) biological geography; (4) industrial and commercial geography; (5) ethnology; (6) topical geography, exploring travels; (7) history of geography and of cartography; (8) methodology, school geography, bibliography, orthography of geographical names. According to the usual custom, the English, French, German, and Italian languages will be admitted as languages of the Congress, and all papers must be written in one of them. The latest date for receiving papers is June 1, 1899; and the subjects should be notified by April 1, 1899. All correspondence relating to the Congress should be addressed to the VII. International Geographical Congress, 90 Zimmerstrasse, Berlin, S.W.

Dr. Capitan has been elected president of the Paris Anthropological Society for 1899.

The Desmazières prize has been awarded by the Paris Academy of Sciences to Dr. J. B. de Toni for his "Sylloge Algarum."

The Paris correspondent of the *Chemist and Druggist* states that a "Retrospective Museum of the History of Chemistry" is being organised to figure in the Paris Exhibition of 1900. It will comprise objects relative to scientific discoveries and industrial improvements—in fact, everything that can clearly show the successive progress accomplished in the chemical industry and the importance of the discoveries made by French savants. Amongst the objects indicated as admissible are laboratory apparatus, reports on discoveries, portraits of inventors, investigators, and manufacturers, descriptions of processes, products obtained by inventors or in scientific laboratories, drawings, plans, models in relief, &c. Industrial museums, faculties, schools, manufacturers, and private individuals are invited to send a list of articles they may be willing to lend.

A prize of 1000 marks is offered by the Economic Society of Mohrungen, near Königsberg, for the best work on the relations of electricity to living organisms. The work must discuss either fundamentally new phenomena in plant or animal electricity, or, from the point of view of physics, discuss the sources of organic electricity, or its significance for life in general or for certain functions.

Very little is at present known of the flora of Porto Rico. This is not likely to remain long the case, since the attention of the Americans has been turned to the island. An American citizen, Mr. Cornelius Vanderbilt, has offered to bear the expense of a botanical expedition to the island by Mr. A. A. Heller, under the auspices of the New York Botanical Garden

An informal Committee will shortly meet in Calcutta to consider the reports by the Astronomer Royal and Sir Norman Lockyer, who were recently asked for advice regarding Indian astronomical and solar observatories. The future working of these observatories will be discussed, and Sir James Westland, Messrs. T. Holderness and J. Eliot, and General Strahan, Surveyor-General, will probably be members of the Committee.

It is announced that the Royal Academy of Medicine of Belgium has appointed a Commission to consider the following proposal:—"The Royal Academy of Medicine asks the Government to enter into negotiations with foreign Governments with a view to drawing up an International Pharmacopoeia."

A SHORT course of lectures adapted for a juvenile audience will be given at the Society of Arts on Wednesday evenings, January 4 and 11, 1899, at 7 o'clock, by Prof. F. Jeffrey Bell. The first lecture will be on "Hands and Feet," and the second lecture on "Some Ways in which Animals Breathe."

THE following are among the Lecture Arrangements at the Royal Institution before Easter:—Sir Robert Ball, six lectures (adapted to young people) on astronomy; Prof. E. Ray Lankester, ten lectures on the morphology of the mollusca; Mr. A. Henry Savage Landor, three lectures on Tibet and the Tibetans; Dr. Allan Macfadyen, four lectures on toxins and antitoxins; the Right Hon. Lord Rayleigh, seven lectures on the mechanical properties of bodies. The Friday Evening Meetings will begin on January 20, when a discourse will be delivered by Prof. Dewar on liquid hydrogen; succeeding discourses will probably be given by the Right Hon. Sir Mountstuart E. Grant Duff, Mr. Victor Horsley, Prof. H. S. Hele-Shaw, Mr. Richard R. Holmes, Sir Frederick Pollock, Bart., Prof. H. L. Callendar, the Right Hon. Lord Rayleigh, and other gentlemen. The year 1899 is the centenary year of the Royal Institution, and arrangements are being made with a view to its celebration in a fitting manner. Details will be announced at a later period.

REFERRING to next year's meeting of the British and French Associations, the Paris correspondent of the *Times* remarks:—Science, happily, has no politics, and the French Association for the Advancement of Science, with the view of fraternising with the British Association, has fixed its next congress for September 14 to 22 at Boulogne. The office-bearers of the two associations have agreed on a joint gathering at Dover during the two congresses. Although the younger association will thus cross the Channel to show its deference for seniority, it is understood that there will be a return visit. The French Association having thus, so to speak, broken the ice, it may be hoped that, just as it has already held a congress across the Spanish frontier, it will before long receive and accept an invitation from some English town. The distance can evidently be no objection, for it has held two congresses in Algeria and a third in Tunis.

SIR WILLIAM JENNER, G.C.B., F.R.S., Physician in Ordinary to the Queen and to the Prince of Wales, died on Sunday, at the age of eighty-three years. From a long obituary notice in the *Times*, we extract the following particulars of his career:—He was born in 1815, at Chatham, and was educated at University College. In 1844 he graduated as M.D. in the University of London; and in 1848 he was appointed professor of pathological anatomy to University College and assistant-physician to University College Hospital. In 1852 he was elected a Fellow of the Royal College of Physicians, and was appointed Gulstonian Lecturer. He then became physician to the Hospital for Sick Children, assistant-physician to the London Fever Hospital in 1853, and full physician to University College Hospital in 1854. In 1857 he succeeded to the professorship of clinical medicine in University College. In 1862 he was appointed Physician in Ordinary to Her Majesty, and professor of the principles and practice of medicine at University College. In the following year he was appointed Physician in Ordinary to the Prince of Wales, and in 1864 was elected a Fellow of the Royal Society. He was created a baronet in 1868, K.C.B. in January 1872, and G.C.B. in 1889. He was President of the Royal College of Physicians from 1881 to 1888, and had received honours from many learned bodies both in this country and abroad. He was a D.C.L. of Oxford, LL.D. of Cambridge and of Edinburgh, a Commander of the Order of Leopold of Belgium, and an honorary member of the Belgian Academy of Medicine. Jenner was not a voluminous writer. His chief works were on the "Identity or non-identity of typhus and typhoid fevers," and on "Diseases commonly confounded under the term continued fevers." He also published his Gulstonian Lectures on emphysema, and two or three volumes of clinical lectures on diphtheria, rickets, tuberculosis, and other subjects.

AFTER a long illness, Sir William Anderson, K.C.B., F.R.S., Director-General of Royal Ordnance Factories, died on Sunday last, December 11. He was born in St. Petersburg in 1835, and was educated at the High Commercial School there, where he was head of the school and silver medallist, and had conferred on him the Freedom of St. Petersburg. He was a pupil of Sir William Fairbairn, and a member of the firm of Messrs. Courtney and Stephens, engineers, of Dublin, from 1855 to 1864. He communicated a number of papers on engineering subjects to the Institute of Civil Engineers of Ireland, and was President of that Society in 1863. He received the Telford medal and the James Watt medal of the Institute of Civil Engineers. He was distinguished for the ability with which he applied his knowledge of the science of heat, and other cognate sciences, to the practical requirements of the engineer. The knowledge of Russian obtained in early life enabled him to translate the works of Chernoff on steel, and the researches of General Kalakontsky on the internal stresses in cast-iron and steel. He was elected a Fellow of the Royal Society in 1891; and was Vice-President of the Institution of Civil Engineers, a Past-President of the Institution of Mechanical Engineers, and hon. D.C.L. of Durham University. In 1889 he was appointed Director-General of the Royal Ordnance Factories, and last year he was created a K.C.B.

A MEMORIAL has been prepared for presentation to the Lord President of the Council (the Duke of Devonshire) and the President of the Board of Trade (Mr. Ritchie), protesting against the proposed removal and distribution of the collection of fish which was brought together by the late Mr. Frank Buckland, and has formed the Buckland Fish Museum in South Kensington Museum. With the view of rescuing the museum and increasing its usefulness, it is proposed that it should be made part of the duties of the inspectors of fisheries to preserve and deposit in the Museum of Economic Fish Culture any objects of permanent interest which may come under their notice, together with models of improvements in fish passes, fish culture apparatus, &c., which may be useful for reference or record. It is also suggested that the secretary and the inspectors of the Fisheries Department, together with the representatives of the Fishmongers' Company, should be appointed visitors to advise on and aid in the efficient management and development of the museum.

THE death of Dr. James I. Peck, assistant professor of biology in Williams College, and distinguished for his investigations in marine biology, is announced in *Science*. The following particulars are given, by Prof. H. C. Bumpas, of his contributions to biological knowledge:—In 1888 Dr. Peck prepared one of the first serious contributions to the study of variation that had been made since the time of Darwin. The summer of 1889 he spent at Woods Holl, where he worked upon the habits of the young of certain food fishes. In 1890 he published his Cymbuliopsis paper. In 1892 he was again a member of the scientific staff of the Fish Commission Laboratory, where he worked upon the Pteropods and Heteropods collected by the *Albatross*. The summer of 1893 was spent in preparing his paper on the "Food of the Menhaden," and in 1894 he continued his plankton studies and prepared a paper on the "Sources of Marine Food." In 1895 he was placed in charge

the Laboratory of the Fish Commission, and in 1896 he ;cepted the position of assistant director of the Marine iological Laboratory.

THE *Chemist and Druggist* announces the death, at Grasse, M. Jacques Passy, who attracted attention some time ago by 's interesting researches on the chemistry of perfumes as gards their composition and physiological action. He was a iemist of promise, and one of the leading assistants of M. lfred Binet, the director of the laboratory of psychological iysiology at the Paris Sorbonne.

M. DE FONVIELLE writes :—"The success achieved on the ght of November 13-14 by the astronomer Hansky in his balon ascent, has induced M. Janssen to undertake further aerial :periments next year for the same purpose. At least two cents are to take place from three different stations; one in urope, one in America, and the last in Central Siberia. hese ascents are to take place respectively and successively—ree on the night of the 13-14, three on the night of the |-15, at 2 o'clock a.m., local time, and to last to 7 o'clock. he aeronauts will be instructed to re-ascend on the following orning, viz. 14 15 for the first, and 15-16 for the second. he balloons are to measure from 50,000 to 60,000 cubic et each in order to carry three men, one aeronaut and vo observers, supplied with electric lamps, celestial maps, ıd chronometers. The balloon is to ascend to an altitude 10,000 feet with registering thermo-baric hygrometer. Free lloons are to be sent up for testing the high atmosphere at an titude of 10,000 feet."

A FINE series of stereoscopic diagrams of the catenaries on a ıtating sphere, a paraboloid and a cone, as well as of geodesic ırves on oblate and prolate spheroids, accompanies Prof. A. G. reenhill's paper in the *Proceedings* of the London Matheatical Society, xxix. pp. 585-670, on "The Catenary and e Associated Trajectory on the Paraboloid and Cone." In e paper itself, the equations and properties of the curves presented are worked out by means of elliptic functions, and e understand that the illustrations are due in great part to ıe co-operation of Mr. T. I. Dewar. In order to make the ırves stand out in better relief, they are mostly drawn on a ıckground ruled to resemble a tesselated pavement.

THE thermodynamics of equilibrium in systems of two and ıree components having one liquid phase, forms the subject of ı interesting paper by Dr. Giuseppe Bruni in the *Atti dei incei* for October (vii. 8), in which the author derives the ıllowing conclusion :—If to a system of two components with nly one possible liquid phase there be added a third comonent which does not combine with the first two and is not omorphous with them, the curves expressing equilibrium of ıe same order (curves of saturation in binary systems and yohydratic curves in ternary systems) are parallel. Only in stems represented by the curve of the ternary mixture, the ıird added component exists mostly in the solid phase.

SINCE Lord Kelvin published in 1856 the details of the ıenomenon known as the Thomson effect, few experimenters ıve turned their attention to experiments of a quantitative ıaracter, Batelli's investigations being almost the only excepon. An absolute measurement of the Thomson effect in ıpper is described by Mr. R. O. King in the *Proceedings* of ıe American Academy of Arts and Sciences (xxxiii. 19). As atelli did not experiment with copper, no direct comparison ith his results can be made, but his value obtained for iron is ıout twice as great as Mr. King's present value for copper. ccording to Tait's assumption the value should be about five nes as great.

ATTENTION seems to have first been called to the errors in localising sounds by E. Weber. The particular problems involved seem to be two, namely, the perception of the direction from which a sound comes and the perception of its distance. An attempt to contribute data towards the solution of these two problems has been made by Matataro Matsumoto, of the Tokyo Imperial University, and his researches on acoustic space appear in vol. v. of the *Studies* from the Yale Psychological Laboratory. The author considers that an acoustic sensation receives its spatial form primarily from the space-idea which is given to us by the visual, tactile and motor sensations. Acoustic space presupposes the existence of the space-form of other sensations. We have only to give an account of how the perception of the position of sounds arises on the basis of the already existing space which was given to us by other senses; as to the further problem of the ultimate origin of the space-form of perception, its solution must be sought in the visual and tactile perception.

THE late Mr. W. J. C. Miller, formerly Registrar of the General Medical Council, was perhaps best known in his capacity of mathematical editor of the *Educational Times*. But he also devoted many of his leisure moments to writing popular articles on natural history, many of which he contributed to the Selborne Society's *Nature Notes* and other journals. These papers are now to be published in a volume entitled "Nature Studies," under the editorship of Mr. H. Kirke Swann. The book should prove very agreeable reading, besides providing, for the many friends of Mr. Miller, a lasting memorial of the author.

A CONVENIENT method of preparing filamentous algae and fungi for the microscope is described by Mr. Charles J. Chamberlain in the *Journal of Applied Microscopy*. Mr. Chamberlain uses Flemming's weaker solution or chromo-acetic acid for fixing, followed by iron alum hæmatoxylin for staining, and mounts in glycerin concentrated by gradual evaporation from a ten per cent. solution. It would be interesting to learn, in applying the method to desmids, whether these can be prevented from their not unfrequently persistent tendency of floating to the surface and getting carried off in the repeated washings that are necessary.

DR. BRINTON has reissued a short article, contributed to the *American Anthropologist*, on "The Peoples of the Philippines." The two stocks which were found in possession of the islands at their discovery by Magallanes in 1521 were the small black Negritos, now reduced to about 10,000 persons, and the brown Malayan peoples, who are in the vast majority. As Dr. Brinton says: "The ethnic and historic relations of these two races offer some interesting problems in anthropology"; and it is not too much to hope, now that America has obtained the sovereignty of the islands, that these problems will be investigated and the results published for the benefit of science. It is painful to be reminded of the absolute neglect of these important matters by the British Government, who, with better opportunities than is possible in any other country, do less than is done by most of the European Governments; while the English student turns naturally with hope to the American Government. Dr. Brinton inclines to the theory, in which we think he is correct, that these two races of the Philippines are ethnographically distinct. The Negritos, so called, are extremely rude, owning no fixed habitations, not tilling the soil, making no pottery, and possessing no clothing except a girdle. Among their beliefs is that when one of their own people dies it is due to the black art of their Malayan foes, and they kill a Malayan if they can. This has given rise to a curious and significant relationship between the conquerors and conquered, which Dr. Brinton does not mention by the way; and we think there is a good field for observation here in a matter not always accessible to the inquirer, but which is, nevertheless, of the

greatest importance. Of course, Dr. Brinton's note is only a summary of the present knowledge, but it is welcome.

IN *Das Wetter* for November, Dr. W. Meinhardus, of Berlin, discusses a fall of ice or frozen rain which occurred over a large part of the central and eastern parts of Germany on October 20. This phenomenon, which is sometimes called glazed frost, is one of the most peculiar and rarest forms of precipitation, which covers all bodies upon which it falls with a more or less thick layer of ice. From the reports received at the Berlin Meteorological Office, it appears that the frozen rain occurred with extraordinary violence in several localities. At Potsdam, Dr. Süring calculated that a blade of grass bore eight hundred times its own weight of ice. The ice-coating lasted through the whole of the day, and only disappeared with the setting in of a warm westerly current on the following morning. The occurrence of glazed frost is usually explained by the rain falling upon bodies below the freezing point, but no frosty weather had preceded the fall in this case. The conditions that produced it appear to have been (1) a layer of air in the upper regions, with a temperature above the freezing point; (2) this upper layer must have been moist, and have had a tendency to move upwards, so that condensation and rain-formation occurred; and (3) below this layer there must have been another stratum with a temperature below the freezing point. This inversion of temperature conditions is borne out by observations received from several of the mountain stations.

A PAPER on the ventilation of tunnels and buildings was read at the Institution of Civil Engineers, on December 6, by Mr. Francis Fox. In regard to the first part of the subject, Mr. Fox enunciated the proposition that if the amount of carbon dioxide in the air of a railway tunnel did not exceed 20 parts in 10,000, then the ventilation might be deemed satisfactory. The case of the Metropolitan Railway tunnels, having been the result of recent investigation, was not mentioned otherwise than to recall the fact that the amount of carbon dioxide in the air had been shown to be as much as 86 parts per 10,000. The great Alpine tunnels were next referred to. In the case of that under Mont Cenis, 8½ miles long and 26 feet wide, the higher altitude of the middle of the tunnel above its entrances was inimical to good ventilation, and at times great difficulty was experienced in carrying on the traffic. The St. Gothard Tunnel, 9¼ miles in length and 26 feet wide, was nearly level from end to end and, until recently, natural ventilation only sufficed, but, owing to increase of the traffic and the use of briquette fuel, the Saccardo system had lately been introduced. This consisted in blowing into the mouth of the tunnel a large volume of air which, on the principle of the injector, caused an induced current in the annular space between the interior surface of the tunnel and the gauge of maximum construction. In the second part of the paper Mr. Fox referred to the statement by Dr. Ransome, F.R.S., that 70,000 deaths occurred annually in Great Britain from tuberculous disease, nearly all of which could be saved were the subject of fresh air both understood and acted upon by the community. Competent medical authority considered that the quantity of carbon dioxide in the air of rooms should not exceed 10 parts per 10,000, equivalent to about 16 cubic feet per head per minute. In French hospitals 50 cubic feet per patient per minute was allowed. Mr. Fox considered that 20 cubic feet per minute would be sufficient for ordinary purposes. Tables were given of the impurity in the air of schools, with different systems of ventilation, of that in dwelling-houses, and of that in sewers; from which it appeared that the latter was the least impure of the three.

PROF. W. F. GANONG, of Smith College, Northampton, Mass., U.S.A., is desirous of obtaining accurately determined seeds of Cactaceæ for studies on the embryology of the order. His investigations on this subject are being published in th *Botanical Gazette*.

DR. N. WILLE has been appointed curator of the Museum and Herbarium of the University of Christiania, in succession t the late Prof. Blytt; and Dr. Carl Fritsch has been elected t succeed Kerner v. Marilaun as director of the Botanica Museum at Vienna.

LORD LISTER'S recent remarks upon the humanity of vivi section, reported in NATURE of October 20, have induced th Hon. Stephen Coleridge to gather a few extracts from th medical journals and the *Journal of Physiology*, and presen them as evidence of "prolonged and terrible tortures." Thi he does in the hope that Lord Lister will "*do himself* the justic to confess that his statement at Liverpool was inaccurate"!

THE English equivalent of the German word "Anlage" i still a matter of discussion among biologists. Among the word favoured by various writers are forecast, fundament, rudiment beginning, origin, and foundation. Dr. Arthur Willey recentl suggested in these columns (August 25, p. 390) the word prim ordium as an accurate and well-sounding rendering of Anlage Prof. Burt G. Wilder expresses a favourable opinion upon thi word in *Science*, but thinks the shorter word proton, alread familiar in numerous compounds, and used by many biologists is a better equivalent.

DR. AMICO BIGNAMI, lecturer in the Institute of Patho logical Anatomy of the Royal University of Rome, discusses i the *Lancet* the inoculation theory of malarial infection, an gives an account of a successful experiment with mosquitoes He remarks at the end of this week's contribution: "To sum up, malaria is a disease which is contracted by inoculation—a fact of which we have now obtained the first experimenta proof, since we have seen that an individual who has never ha malarial fever by sleeping in a healthy place where no one ha ever previously taken fever may sicken with malaria of a grav type if bitten by certain species of the mosquito brought in th adult state from some distant locality of highly malariou character. Further, everything points to the conclusion tha inoculation is the only mode by which infection is acquired since air and water as carriers of infection may be excluded and because arguments based on analogy all tend in the sam direction. This much at any rate we can assert—namely, tha inoculation is the only mechanism of infection which has bee demonstrated experimentally."

AN elaborate illustrated catalogue of apparatus used i physical and chemical laboratories and lecture rooms, an for bacteriological and microscopical work, has been issued b Messrs. W. and J. George, Ltd., the successors of the firm o Messrs. F. E. Becker and Co. The catalogue runs into no les than 662 pages, is printed on good paper, and profusely illus trated with pictures (many of them new) of instruments an accessories. Special attention appears to have been give to the arrangement of the contents, the description and pric of each piece of apparatus being immediately adjacent to th illustration of the apparatus. The overcrowded appearance o many catalogues of scientific apparatus is thus avoided, and all particulars with regard to any instrument are readily found The catalogue should be seen by teachers and investigators o all branches of experimental science.

IN a recent number of the *Journal für praktische Chemie* is an interesting contribution by Prof. Curtius and Dr. Rissom to the chemistry of azoimide and its metallic derivatives. Some losses having been noticed during the preparation of azoimide, by distilling a metallic salt with acid, it was found that heating

in contact with dilute mineral acids caused notable decomposition of the hydrazoic acid. A large number of metallic salts were prepared and analysed, and in every case the salts were found to be anhydrous. The metallic derivatives differ considerably in their explosive properties. Thus, of the derivatives containing the metals of the alkalis and alkaline earths (with thallium), lithium nitride is the only one exploding violently on heating, and thallium nitride the only one detonating when struck on an anvil. The action of heat upon the nitrides of these two groups is very remarkable, as when small quantities of the nitride are heated carefully in thin glass tubes, decomposition takes place quietly, nitrogen being evolved, and the pure metal left behind; this being, as the authors point out, much the easiest method of preparing small quantities of barium, strontium, and calcium.

THE additions to the Zoological Society's Gardens during the past week include an Egyptian Jerboa (*Dipus aegyptius*) from North Africa, presented by Miss Da Costa; an African Buzzard (*Buteo desertorum*), an Iceland Falcon (*Hierofalco islandus*), captured in the Red Sea, presented by Captain E. W. Burnett; a Peregrine Falcon (*Falco peregrinus*), captured in the Red Sea, presented by Captain Bear; a Rough-keeled Snake (*Dasypeltis scabra*) from South Africa, presented by Mr. H. Oakley; two Scops Owls (*Scops giu*), South European, deposited; a Brazilian Tapir (*Tapirus americanus*, ♀) from the Upper Amazons, two Common Rattlesnakes (*Crotalus durissus*) from North America, purchased; an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE GEMINIDS.—For the greater part of the evenings of the 10th, 11th and 12th of this month, clouds prevented observations of the Geminids in London. Late on the night of the 12th, however, when the sky became to some extent clear, a brief watch of an hour, from 11h. 30m. p.m. to 12h. 30m. a.m. G.M.T., disclosed the fact that these meteors were very much *en evidence*. Between 11h. 30m. and 12h. 5m. no less than twenty-four Geminids were observed, four of which were of great brilliancy and brighter than a first magnitude star. The direction of observation was necessarily restricted towards the north-west. Curiously enough, a further watch from that time until 12h. 30m. was only rewarded by the observation of one meteor, and that not a Geminid, which gave one the impression that the shower had terminated. Clouds prevented further observation. Whether the shower was more brilliant earlier in the evening cannot, so far as this place of observation is concerned, be stated. Another observer, Mr. W. E. Rolston, of the Royal College of Science, South Kensington, was also surprised at what appeared to be quite a shower of meteors on the same evening. He recorded the appearance of several meteors during the interval 11h. 15m. p.m. to 12h. 20m. a.m. G.M.T., one of which, as he describes, "an exceptionally long and bright one, leaving a long trail of reddish sparks, which lasted for about two seconds." The same observer also mapped nine true Geminids on the night of the 9th.

COMET CHASE.—Using the same elements as those we published in our last number, the following is the ephemeris for the current week.

Ephemeris for Berlin Mean Midnight.

1898.	R.A. (app.) h. m. s.	Decl (app.) ° ′	Br.
Dec. 14	10 47 51	+25 49·3	1·39
,, 16	49 51	26 6·0	
,, 18	51 44	26 23·4	
,, 20	53 31	26 41·3	
,, 22	10 55 11	+26 59·8	1·39

The comet is thus still in the constellation of Leo, and is situated approximately between 54 and 57 Leonis. It is now brighter than it was at the time of its discovery. Prof. E. Weiss thinks that it may be identical with 1867 I.

It is interesting to remark that the comet was discovered photographically near the radiant point of the Leonid meteor swarm. Four other photographs taken—two at the Yale, and two at the Harvard observatories—have corroborated its presence.

THE TOTAL SOLAR ECLIPSE OF JANUARY 22, 1898.—We have received from the Survey of India Department the report on the observations made at Dumraon, Pulgaon, and Sahdol during the recent solar eclipse. The report is divided into three sections, each section giving an account of the arrangements and observations made at the three different stations. The first, somewhat necessarily brief, is written by Mr. T. A. Pope, Assistant Surveyor-General, who had charge of a three-inch photographic doublet. With this instrument an excellent series of plates of the corona was obtained, one of which is reproduced as frontispiece to the present volume. The Pulgaon report, by Captain G. P. Lenox Conyngham, R.E., contains an interesting and well illustrated description of the camp, and the programme which the party had before them. Mr. Newall and Captain Hills, it will be remembered, occupied this station, and received valuable assistance from the officers and others present. The report on the observations at Sahdol, by Major S. G. Burrard, R.E., is somewhat more voluminous than the two preceding. In addition to a general account of the arrangements as regards the camp distribution and the preparatory work of the observers, such results as could be immediately deduced are given. Thus, for instance, we have a comparison between the temperature curves obtained on the actual and following day of the eclipse, showing clearly the drop from the time of first contact to about half an hour after totality, and the subsequent rapid rise. The large assembly at Sahdol made it possible to organise a party to make sketches of the corona. This was done, with the result that we have here thirty-one facsimiles of the hand-drawings made. After an examination of these sketches, we can truthfully remark, with Major Burrard, that "the accordance between these drawings is more remarkable than their discrepancies." The remaining portion of the report is devoted to a brief summary of the Hindu method of eclipse prediction, a chapter on future total solar eclipses in India, with twelve charts of tracts of past and future solar eclipses, and lastly to the answers to a series of questions concerning the corona and the attendant phenomena.

The volume, which is published under the direction of Major-General C. Strahan, R.E., the Surveyor-General of India, is very well illustrated, and should serve as a useful guide and source of valuable information for future eclipse expeditions.

NOVEMBER METEORS. — The *Harvard College Circular* (No. 35), which has just come to hand, describes in a brief manner an account of the preparations for observing the Leonid shower in America, and the preliminary results obtained. It will be remembered that last year Prof. E. C. Pickering organised a large staff of observers not only to make visual observations, but to record, if possible, their trails and spectra photographically. This year the organisation was even more complete, and stations were selected all round the earth in order that the number of visible meteors might be counted during the entire period that the earth passed through the swarm. The present *Circular* deals with the observations made at Cambridge (U.S.A.) and Providence, the reports from other stations not having yet arrived.

At the former town the night of the 13th was cloudy, but the 14th was clear. Thirty persons at the observatory recorded 800 meteors, not including duplicates, the maximum number having occurred at 3 o'clock in the morning, when 61 meteors east of the meridian were counted in thirty minutes. No less than 227 trails of eighty different meteors within 30° of the radiant were charted. At Providence the vicinity of the radiant point was continuously watched by at least ten observers, and 400 meteors were seen. Prof. Pickering chose this station (which is forty miles south of Cambridge) for visual determinations of parallax.

As regards the success of photography for this work, the results obtained seem very promising. Ninety-six photographs were taken at Cambridge with the Draper telescopes, and eleven with smaller instruments. Not only were photographic doublets employed, but prisms were utilised; but these, unfortunately, failed to give any record. By means of the doublets thirty-one trails of eight different meteors were photographed, three of which appeared on one plate. Four meteors were photographed at both stations, so that the parallax can be obtained photographically. A preliminary determination of the radiant point

gives the position for 1900 as R.A. 10h. 6·8m., Dec. + 20° 16m., which is 9m. following, and 38′ south of that given by Denning. Some peculiarities of the photographed trails were that they attained a maximum and then diminished as rapidly as they increased, sudden changes due to explosion were well shown, the trail was sometimes surrounded by a sheath of light, and lastly, in one case the trail remaining after the meteor had passed was recorded.

ASTRONOMICAL CONGRESS AT BUDAPEST

As was announced in NATURE of August 25, the International Astronomical Association (*Astronomische Gesellschaft*) held its seventeenth Congress at Budapest at the end of September.

The meeting was an unusually large one, and the reception by the Hungarian colleagues and the scientific and political authorities was exceedingly cordial. There were present, amongst others, the directors of the Observatories of O'Gyalla (von Konkoly), Hérény (von Gothard), Kalocsa (Father Fenyi, S.J.), Vienna (Weiss), Munich (Seeliger), Karlsruhe (Valentiner), Heidelberg (Wolf), Göttingen (Schur), Jena (Knopf), Berlin (Foerster), Breslau (Franz), Bamberg (Hartwig), Turin (Porro), Upsala (Dunér). Besides these, many well-known astronomers attended, such as Müller, of Potsdam; Nyren, of Pulkova; Pechüle, of Copenhagen; Schröther, of Christiania; Kreutz, director of the International Bureau at Kiel, and of the *Astronomische Nachrichten*; Bauschinger, director of the Institute of astronomical calculations of Berlin, and many others. The absence of English and French astronomers, many of whom form part of the Society, was much regretted, and perhaps it is due to this fact that the Congress, out of natural reserve, abstained from raising the question of the fundamental stars and constants, resolved, perhaps too hastily, by the Conference at Paris in 1896.

The first meeting was opened by President Seeliger on September 23, in the large hall of the Academy of Science, where all the subsequent meetings were also held. Von Wlassics, the Minister of Education, who afterwards offered lunch to the members of the Congress, the burgomasters of Budapest, and Baron Eötvös, President of the Academy, well known for his experiments on gravitation, attended.

In the meetings of September 25, 26 and 27, besides other affairs of the ordinary business of the Society and the confirmation of the members of the Presidency, retiring by seniority, many scientific subjects, briefly referred to here, were discussed. Prof. Schür described the new reductions of the observations of planets and comets, made at Bremen by Olbers. Such reductions are made after the original notes of Olbers, placed at the disposal of the Gottingen Observatory. Dr. A. Stichtenoth, together with Prof. Schur, takes part therein. In the first place are discussed the determinations of time made by Olbers through observations of the setting of the principal stars behind the vertical side of the tower of the observatory, then the measures of the radius of the circular micrometer adopted, by the medium of the observations of couples of stars applied to the comparison with one particular comet; and lastly, these same planetary and cometary observations. In the published papers the times of the observations and the distances along the circle of declination of the comet and the comparison stars from the centre of the ring will be given. It is hoped that it will be possible to place these important materials at the disposal of astronomers during next year.

Dr. Bidschof, of the Imperial Observatory of Vienna, gave an account of some catalogues completed by him. These contain a list of the nebulae that were determined micrometrically at the observatory of Vienna up to the end of 1897, besides a stellar catalogue, containing the results of the new observations of the southern stars of Santini, executed at the Viennese observatory.

Dr. Brendel, of Gottingen Observatory, referred to the publication of Gauss's works. Soon after the death of Gauss the editing of his works was confided to Prof. Schering, of the Royal Academy of Göttingen. Schering published six large volumes, but did not succeed in completing the publication, so that, besides the great part of astronomical subjects published in the sixth volume, and the "Theoria Motus," printed in the seventh, the numerical discussion of the perturbations of the motion of Pallas, which will occupy the remainder of the seventh volume, remained unedited. Concerning this, it is necessary to note that, Gauss having left an enormous quantity of material (above half a million of figures) on this subject, without sufficient explanation, the reconstruction of the mode of these calculations becomes very difficult, though not impossible. The so-called libration, connected with the curious phenomenon, by which seven evolutions of Jupiter correspond exactly to eighteen of Pallas, presents special interest. The eighth volume will contain additions to all the materials of mathematics and physics dealt with in the fifth. Finally, the ninth volume will be concerned with biographical matters.

Prof. Franz demonstrated that the lunar globe previous to its solidification must have been elongated in the direction of the earth by the tides produced by our planet. Whilst the theory of tides and the physical libration assigns to such elongation the small amount of 0·0001 of the radius, Gussen, from the measure of two lunar photographs in different librations, obtained the considerable elongation of 0·0500. To eliminate such contradictions between the theory and the observation, Prof. Franz has measured five lunar photographs from the Lick Observatory in various combinations, and found an elongation of the lunar globe of 0·0027. Thus a nearer approach to the theory is reached, which, however, cannot result in complete accord, through the want of homogeneity in the lunar mass. Hansen put forward the hypothesis that the opposite part of the moon was deeper, so that it had gathered on itself water and air, thus rendering animal and vegetable life possible. On this hypothesis a lively and interesting discussion ensued between Profs. Foerster and Franz.

Dr. Witt, of the Urania Observatory of Berlin, observed that a simple glance at the stereoscopic views of the moon shows a considerable elongation.

Dr. Marcuse, formerly delegate of the Geodetic Office of Potsdam, in the Sandwich Islands, for the study of the variation of latitudes, called attention to the necessity of generally extending the methods of photographic registration of the observations of latitudes, applying them in quite a general manner to the geographical determinations obtained in travelling. He considers, having had occasion from 1893 to superintend the construction of a photographic zenithal telescope, and afterwards to use it, that the photographic registration of the measures of altitudes and transits can be easily obtained by means of a convenient universal instrument, adapted to visual as well as photographic measuring; and that with it, surety and precision are gained. An instrument for that purpose is being constructed.

Dr. Max Wolf, of Heidelberg, so well known for his photographic discoveries of small planets, spoke on the researches made by him on an objective worked by Dr. Pauly in Jena, with the aperture of 21·2 cm., and the focal distance of 445 cm. It is formed of the new glass of Jena, and must possess better chromatic corrections than the old systems. In fact, the investigation with the spectroscope has shown that the colours are exactly comprised from the extreme red to the blue; only towards the G line the colours begin to deviate. A comparison of the curve that represents the position of the focal points corresponding to the various colours, with analogous curves given by objectives of Fraunhofer, Grubb and Clark, shows the superiority of the objective of Pauly to the best anterior ones. While the deviation of the focus in the middle of the blue scarcely reaches to 0·00003 of the focal distance, that of 0·00065, determined by Clark, is far the least considerable of those remaining. The correction of sphericity is also small. Many delicate couples of stars are separated; *e.g.* η Coronae (distance 0·″4), μ_2 Bootis (0·″9), ι Coronae (0.″4), λ Cassiopeiae (0·″6), μ Cygni (2·″9), ξ Hercules (0·″5), $o\Sigma$ 338 (0·″7), Σ 2695 (0·″9), Arcturus in the angle of position 120° appears lengthened; ζ Bootis and 52 Arietis could not be resolved. The size of the stellar discs amounts to 0·″24 for the sixth magnitude, to 0·″15 for the eighth. Dr. Pauly added some explanations on the manufacture of the new objective. The first attempts to eliminate the secondary spectrum go back to the year 1886; but then the glass used was not suitable. Only for two years has it become possible to obtain a new glass perfectly well adapted, the dispersive properties of which insure absolute elimination of the secondary spectrum. The pictures of the sun and moon are surprising, especially of the moon.

Prof. Porro presented a paper by the new member of the Association, Prof. Vito Volterra, of the Turin University, on the mechanical theory of the motions of the terrestrial pole. In this paper are recapitulated the results of a more extended work, which will be published in *Acta Mathematica*.

Following upon this communication, Prof. Porro gave an account of the present state of the calculations being made at New York and Turin for a new reduction of the observations of Piazzi, and for the compilation of a stellar catalogue founded on the same. According to arrangements made between Dr. Auwers and Prof. Schiaparelli, the work is divided between Dr. Herman S. Davis, of the Columbia University Observatory, and Prof. Porro. Mrs. Coreita R. Davis shares in it at New York, Dr. Vittorio Balbi at Turin.

A third notice given by Prof. Porro concerns the eighteen tables, in which he has had reproduced in facsimile the original sketches of the constellations, drawn by Francesco Bianchini in the seventeenth century.

The sketches contain the first essays on exact relative ocular determinations of the stellar magnitudes, executed by a method not differing essentially from that suggested and applied a century and a half later by Herschel. Argelander and Schiaparelli had deplored the loss of these papers, which ought to be of service for the historical study of the variable stars. The speaker had been able to find the manuscripts in a code of the Capitular Library of Verona, to which Bianchini, when dying, had bequeathed all his books; and had found that, without giving to the afore-named study the contribution expected by Bianchini and Montanari (of which also observations are reported), the papers themselves furnish the first document of exact determination of the relative magnitudes of the stars, which is recorded in the history of astronomy, resolving the query propounded by Argelander in his paper, "De Fide Uranometriae Bayeri."

Dr. Fritz Cohn, of Königsberg, described some general results of a new reduction of the most ancient meridian observations of Bessel. Of the observations made by Bessel in the years 1814–19, none had been published till now, save the known Fundamental Regiomontan Catalogue of Maskelyne's thirty-six stars for the epoch 1815. Bearing in mind the date of the observations and the name of the observer, it had been thought desirable to undertake a reduction of the materials gathered together. As the fundamental problem it seemed necessary to show the systematic errors of the Besselian method, and eliminate the damaging effect. Inasmuch as the presentation of the systematic errors in Bessel's catalogue depends considerably on the method of reduction adopted, it was needful to seek for a method that should limit as much as possible the influence of the systematic errors on the results. Applying a method studied purposely to such an end, a considerable improvement of Bessel's catalogue was obtained. But a perfectly satisfactory result could not be obtained till the cause of the error was discovered in a different distribution of the passages of the stars between day and night, and until such cause could be exactly calculated. After such a result it would be desirable that also in other series of observations of fundamental stars, especially ancient ones, search should be made of eventual systematic errors, because it is to be expected that from the consideration of these the accuracy of the results would gain considerably.

Prof. Foerster read a brief notice on some questions connected with the length of the year and the calendar. The numerous numerical data on which his discourse was founded do not lend themselves to a recapitulation of the interesting matter treated with the usual ability by the illustrious director of the Berlin Observatory.

On the measurement of the brightness of the nebulae and the clusters of stars, spoke Dr. Holetschek, of Vienna. He has been occupied for several years in determining the luminous impression made by the light of a comet through the weakest telescope in which the comet itself is visible, and eventually by the naked eye, noting the stars that are visible with equal facility or with equal difficulty in the same conditions. In this manner it has been possible for him to represent such luminosity with numbers, and now he has begun the application of the same system to nebulae and clusters of stars also. Manifestly, the method does not lend itself equally well to all classes of similar celestial objects: in particular it is not adapted for nebulae illuminated diffusely and uniformly, and for clusters of stars spreading over a wide space, as those in the Classes VII. and VIII. of Herschel.

Applying his method to objects of the first two classes of Herschel, Holetschek has found, for instance, that the brightness of the Pleiades corresponds to magnitude 1·5, that of the Presepe of Cancer to 4, of the nebulae of Andromeda to 5·3. Messier having compared the brightness of the comet 1779 to that of four different nebulae, of brightness 6·5; 7; 8·7; and 9·6, the author has been able to extract good values for the brightness of the comet. In the determinations executed between 1886 and now, he did not succeed in recognising any variations in the brightness of the nebulae under observation.

Prof. R. von Kövesligethy, of Budapest University, referred under the title "Ueber die Beiden Parametergleichungen der Spectral Analyse," on the studies just finished by him in the field of spectral analysis, the scope of which is to found astrophysics on mathematical bases. He shows how the two fundamental equations of the theory of heat are destined to have the same importance in astrophysics as the principles of mechanics have in astronomy, and that it is only now necessary to determine by observation the quantities that figure in such equations. To such an end the equation of emission is formed very simply in function of the length of the wave, and of two parameters that depend on the nature of the bodies; and it is not difficult to prove that the proceeding is severe, recurring to the proposition of Clausius on the radiation and to the equations of dispersion. Besides, it represents perfectly a series of bolometrical measures of the spectrum. The author insisted on the application of his theory to very important questions, also of mathematical astronomy, as the determinations of the parallaxes, the volume and densities of the heavenly bodies.

Father Fenyi, S.J., spoke on the observations of solar protuberances at the Kalocsa Observatory from 1884. He noted, first of all, that the greatest heights of the protuberances observed evidently depended upon the greatest amount of solar activity. With regard to the nature of the protuberances, he observed that they appear in the absolute vacuum, according to the theory of Schmidt, by which the density of the critical stratum around the sun could be determined with accuracy; but hydrogen cannot have a greater density than that of the critical stratum, and hence the maximum of density possible to hydrogen at every height can be determined. If this density be determined only for a height of 25″, it is seen directly that no trace of hydrogen can exist there; because on a volume equal to that of the sun a single molecule alone would fly from it. The theories that contradict this result are, therefore, to be rejected.

Prof. Hartwig, of Bamberg, called attention to the star SS Cygni, which, together with U Geminorum alone, forms a special class of variables, that offers special occasions, by its connection with new or temporary stars, to the study of these mysterious stellar bodies. The character of this class consists of an unexpected lighting up, followed by a rapid increase of magnitude, after which comes a slow return to the usual brightness. The spectographic study of SS Cygni seems possible for the large instruments now in activity, and would certainly furnish useful information on the causes of similar mysterious phenomena.

Another communication was made to the Congress by Prof. Kreutz, who referred to the actual state of the calculations of cometary orbits.

Among the numerous visits made by the members of the Congress to noteworthy places in the city and in the kingdom of Hungary, special mention should be made of the O'Gyalla Observatory, where the splendid hospitality of Dr. von Konkoly was not less admired than his munificence in preparing and presenting to the State a magnificent collection of instruments, designed by him and constructed under his direction, and of the Institute of Physics of the Budapest University, where they attended the experiments on gravitation of Baron Eötvös. The general impression that remained was of sincere admiration for the very notable progress made in the field of science by the country of Hungary, whose name was given to a new planet discovered by Wolf.

FRANCESCO PORRO.

RECENT PROGRESS IN ORNITHOLOGY.[1]

As the editors of *The Ibis* have already remarked in their preface to the volume for the present year, one of the leading ornithological events of 1898 is the completion of the "Catalogue of Birds." The twenty-sixth volume of this work, prepared by Dr. Bowdler Sharpe and Mr. Ogilvie Grant, the only one required to finish the series, will, I am assured, be

[1] Address given by Mr. Sclater at the opening meeting of the British Ornithologists Club, on October 19.

laid before the Trustees at their next meeting, and be ready for issue very shortly afterwards. Thus, after a period of twenty-five years, this most important piece of ornithological work has been brought to a conclusion. No human product is perfect, and the Catalogue has been, and will be, the subject of many criticisms. One obvious defect in it is its want of uniformity, the various authors having been permitted, owing to the wise discretion of the authorities, very liberal opportunities for the expression of their own views in their respective portions, although a general adherence to one plan has been rightly insisted upon. But when the enormous amount of labour required for this work, and the absolute necessity of employing more than one author upon such a huge task are considered, it will be obvious that greater uniformity was practically unattainable. In the case of the "Catalogue of Reptiles and Batrachians," where the series of specimens and species was not so large, the herpetologists are fortunate in having had the whole of the work performed upon a uniform system by the indefatigable energy of a single naturalist.

The "Catalogue of Birds," as complete in twenty-seven volumes, gives us an account of 11,614 species of this class of Vertebrates, divided into 2255 genera and 124 families. It has been prepared by eleven authors, all members of the British Ornithologists' Union, and with one exception, I believe (who is not a resident in England), now or formerly members of this Club. I think it will be universally allowed that we have, in this case, a great and most useful undertaking brought to a successful conclusion.

Another good piece of ornithological work, likewise the product of a member of this Club, which has just made its appearance, is Mr. Beddard's volume on the "Structure and Classification of Birds." It seems to me to be a most useful manual on this subject, profusely illustrated, and full of convenient references to further information on various points which it would have been impossible to compress into a single volume. It will be found to be a mine of wealth to those who choose to dig in it, and contains a good summary, not only of the results arrived at by Mr. Beddard himself, but also by Garrod and Forbes, his illustrious predecessors in the office which he holds.

Mr. A. H. Evans, whose volume upon Birds for the "Cambridge Natural History" we have been long expecting, informs me that this work is finished, except the index, and will be shortly published. We shall all welcome its appearance with the greatest pleasure. A second work that Mr. Evans, together with Mr. Scott Wilson, is engaged upon is the "Aves Hawaiienses," of which we have long been waiting for the final part. This, I am assured, is now in a forward state, and is likely to be issued without further delay.

From information received from Mr. Rothschild, I am pleased to be able to say that his somewhat parallel illustrated work on the "Avifauna of Laysan," of which the last part was issued in 1893, will also be shortly brought to a conclusion, and that the third and final part will be issued in the course of next year. Taken together, these two works will form a most valuable contribution to our knowledge of the Avifauna of the Northern Pacific. I must also not forget to mention, amongst recent contributions to our science, the excellent work of Dr. Meyer and Mr. Wiglesworth on the birds of Celebes—one of the most elaborate and complete ornithological monographs on the birds of a special district ever prepared. Celebes, I may remark, as a debatable land between the Australian and Oriental regions, was in special need of the full treatment and discussion which it has here received from the authors of this work.

But the brethren of the B. O. C. and their friends, I think I may say, are at present not less active in the field than in the cabinet. We are fortunate in having with us to-night the two principal members of the new expedition to Socotra and Southern Arabia, which will leave England on the 28th inst. It will, of course, take up natural history in every branch, but with Dr. Forbes and Mr. Ogilvie Grant as its leaders, and a trained taxidermist in attendance, we need not fear that the interests of Ornithology will in any way be overlooked. In Socotra itself much has been already done, but little or nothing has been ascertained ornithologically of the southern coast of Arabia, and we know, from Bent's writings, that even in this commonly supposed barren district, bird-life is abundant in certain spots, which we trust may be within reach of the Expedition.

Besides the Socotran Expedition many other explorations by various members of the B. O. U. are in progress or in contemplation. Captain Boyd Alexander, who has worked so well in the Cape Verde Islands, is struggling through the middle of Africa from the Cape to Cairo. Under present circumstances he seems likely to come out successfully, and will, no doubt, bring information on birds, if not specimens, with him. Mr. Lort Phillips hopes to return to his favourite quarters in Somaliland during the course of the present winter, and expects to get together the supplementary materials still required for the preparation of his proposed work on the birds of that most interesting country. Mr. John Whitehead, who has added so much to our knowledge of the zoology of the Philippines, proposes to return to the same country very shortly, in order to continue his researches in a field which he knows so well and in which he takes such great interest. Before leaving, he has placed in the hands of the editors of *The Ibis* a series of valuable field-notes on the birds collected during his last journey. These will appear in the forthcoming volume of our journal. Mr. Alfred Sharpe, C.B., who is shortly returning to his post in Nyasaland, promises to continue the employment of collectors in different parts of that Protectorate, the zoology of which he, following in the footsteps of Sir Harry Johnston, has already done so much to investigate.

Finally, I may remark that, as will be seen on turning over the pages of contents in the last volume of *The Ibis*, we have correspondents interested in our favourite subject in nearly every part of the world, and that the great difficulty of the editors is to compress so many valuable contributions within the compass of an annual volume.

Before resuming my seat, I wish to say one more word. Our Government, in connection with that of Egypt, has just taken possession of an enormous district in Africa, probably nearly equal to half Europe in extent. It sternly warns all intruders off, even when they are alleged to be of "no political influence." When it comes to regulate the administration of these new territories, it is to be hoped that the interests of natural history will not be entirely overlooked. Although the Upper Nile districts have been traversed and investigated by many well-known naturalists, there is still very much to be done in these teeming regions of animal-life. We Englishmen are ready and willing to undertake, by individual efforts, much work that in other countries is provided for by State explorers; but it is not too much to expect that our Government should at least help us by providing adequate facilities and occasional assistance, and even, perhaps, by contributions to the expensive process of bringing the results thus acquired completely before the world.

THE ECONOMIC EFFECTS OF SHIP CANALS.

In a paper submitted to the American Academy of Political and Social Science by Mr. J. A. Fairlie, on "The Economic Effects of Ship Canals," it is pointed out that while the construction of the North Sea Canal doubled the tonnage of the shipping of Amsterdam in the first six years after it was opened, the effect was purely local, as will be that also of the Manchester Ship Canal; and that although the Welland, Corinth and Kiel Canals have larger possibilities, their actual consequences have as yet been small. With the Suez and Sault Saint Marie Canals the results have been both important and far-reaching, and have affected the trade of the world. Both these canals have led to a rapid change in the material and character of the vessels used; to important changes in the sources of production; to the development of the growth of wheat in the countries which they serve; and to a large reduction in the cost of bread and other food in this country.

The Suez Canal opened in 1870 with a traffic of 486 vessels having a tonnage of 436,000 tons; in 1891, the record year, the traffic had increased to 8,700,000 tons. The new route by effecting a saving of 3000 miles on the voyage from the ports of Western Europe to the East, or almost half the distance to Bombay, brought about a complete revolution in the character of the shipping business to the East. By the Cape route coaling places were few, and the facilities for coaling expensive; the consequence was that owing to this, and the large space occupied by coal, to the exclusion of paying cargo, sailing vessels were more profitable than steamers. By the canal, steamers can coal at Gibraltar, Malta, Port Said and Aden; consequently,

owing to these facilities and the shorter distance, sailing vessels soon became superseded by steamers, and it was estimated that 2,000,000 tons of vessels were thus thrown out of employment. Under the old system, when voyages from India took the greater part of a year, and the time of arrival could not be calculated within a month or two, it was necessary to keep large stocks to meet the varying demand for goods, and hence the erection of the enormous range of warehouses at the India Docks. Steamers by way of the canal make the voyage in thirty days, and the time of their arrival can be regulated within a day or two; shorter voyages and punctuality of arrival make it possible for merchants to order direct from the East, and hence less capital is required and the cost of warehousing saved. The Suez Canal has had a material effect in fostering the growth and export to this country of Indian tea, which has increased from 11 to 120 million pounds. The export of rice from India has also enormously increased since the opening of the canal, and now constitutes the largest single item in the export trade of India. When the only route was round by the Cape the difficulty in transporting wheat, owing to its liability to heat during the voyage, and the loss from weevils, made the export of grain unprofitable. Since the opening of the canal India has become the second exporting country of the world, the exports of grain amounting now to over 50,000,000 bushels.

Other merchandise, both of import and export, has been affected to a less degree; the shorter route has also rendered possible the export from Australia and New Zealand of very large quantities of meat, fruit and other food products.

The Saint Mary Falls Canal, commonly called "The Soo," has now a traffic even larger than that of the Suez Canal, and exceeds the total foreign trade of the port of New York. The development of the trade now carried on over the Great Lakes is almost entirely due to this "Soo" canal. The size of vessels engaged in the navigation in 1870 averaged 175 tons; now there are five lines, owning sixty steamships of from 1750 to 3000 tons. The increase in trade is due in a great measure to the opening out of the iron mines of northern Michigan and Wisconsin, which have been made available by the canal route from the mines to the ports in the southern lakes. But the most important factor in the increase of the navigation is the transport of wheat and flour, the low rates at which these can be carried by water encouraging the growth over a very widely extended area of country. The other resources which have been developed by the construction of this canal are timber, coal and copper. One conspicuous feature due to this canal is the immense increase in population in the Lake Superior region and the development of towns.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

THE Anthropological Section met in the Park Place Schoolroom, under the presidency of Mr. E. W. Brabrook, C.B., ex-President of the Anthropological Institute.

On Thursday, September 8, the morning's programme consisted mainly of papers on physical anthropology.

The sixth annual Report of the Committee on the mental and physical deviations from the normal among children in public elementary and other schools was read by Mr. White Wallis, and gave a further account of those children whose mental and physical condition renders them unfitted for the public education provided in ordinary elementary day schools. The new information has been mostly obtained by studying the correlations of the cases, and the facts tabulated show that great difficulties must arise in making any provision for the proper care of these children, who show a much greater tendency than average children to become delicate under an adverse environment. The large proportion of both boys and girls who present "abnormal nerve-signs" shows the importance of trying to remove each such sign by carefully adapted physical training, and that the improvement of the brain condition of such children below the average in mental and physical development requires skilled teachers and good hygienic surroundings.

Mr. O. H. Howarth read a paper on human life at high altitudes, with the object of determining whether the adaptability of man to extreme conditions is of comparatively recent development, or of gradual growth. He exhibited an object which he regarded as a stone celt, found at an elevation of 7700 feet in the Rocky Mountains in Colorado. As causes of human inhabitation of extreme altitudes, he named the pursuit of industries impracticable elsewhere, and seclusion for religious purposes, and enumerated the conditions favourable and unfavourable to the persistence of human life under these conditions. He described numerous specialised superstitions; especially the impulse to establish cults on high peaks, and the belief in disembodied spirits, leading to a variety of precautions to prevent their interference. In the discussion which followed, Dr. Beddoe pointed out that Tibet, which was the highest average altitude in the world, was the only place in which real theocracy existed, and that the shepherds in remote parts of Australia often became demented because they were so much alone. Dr. Francis Galton thought it would be worth while to observe the behaviour of animals in high altitudes. Prof. Tylor suggested that some attention might also be directed to the collection of literature dealing with this subject. Mr. C. H. Read regarded the object exhibited by Mr. Howarth as a purely natural production, not a manufactured implement. Dr. G. A. Dorsey and Dr. J. G. Garson continued the discussion. Mr. Howarth briefly replied.

Miss M. A. Ellis presented a note on the human ear as a means of identification, stating that ears do not change shape after childhood, and classifying the great varieties of shape by marking off the *helix* into five divisions. Various types of ears were exhibited, and a brief discussion followed.

Mr. K. Minakata's paper on *Tabu* in Japan was read in abstract.

Mr. G. Leith read an important paper on a large and varied collection of stone implements from South Africa, describing the situation and characteristics of the bushmen's haunts, in some of which were found implements and other signs of occupation, just as they had been left years ago; and remarking upon the various types of stone implements which are found both in the cave deposit, and in the talus in front of the cave. With these poisoned arrows the bushmen were a dangerous enemy to the Boers, even when the latter were equipped with firearms. The investigation of Lighthouse Cave, at Cape St. Blaize, led to the discovery of many fine specimens of skinning knives, scrapers, and flaked implements, indicating that it had been a place for the manufacture of these implements for many ages. Alluding to his researches in various beds of gravel at various altitudes in which he discovered large numbers of palæolithic stone implements of very remarkable size and shape, he classified the latter, according to their position, into neolithic or modern, palæolithic or ancient, and eolithic. The evidence of these gravels proved without doubt, in his opinion, that South Africa was the home of man at a very remote period of history. The eoliths found there corresponded exactly with the plateau implements found on the Kentish Weald by Mr. Harrison. Prof. Dawkins did not think that the evidence was clear as to their belonging to the Gravel ages, and had no doubt that he could find a parallel from North America for the specimens produced.

Mr. F. T. Elworthy described a number of Roman symbolic hands from Pompeii and elsewhere, of the kind known as *Mano Pantea*; contending that these hands are not votive offerings, but in fact the Roman Penates. Mr. A. J. Evans and Mr. E. S. Hartland pointed out that these hands all belong to the late heterogeneous cults of the early empire, and have no connection with the indigenous family cults of Italy. Mr. J. L. Myres described other examples exhibited in the British Museum, one of which bears a definitely votive inscription. Bishop Brownlow commented on the Christian benedictory use of the gesture represented in these pre-Christian hands.

Mr. H. Warington Smyth described the river craft in use among the Siamese, explaining the construction of the "dug-out" Me Kawng boats, and discussing the various native types. To this was appended a brief description of the simple fourteen-reed instrument in use among the Lao of the Me Kawng Valley, illustrated by an example of this characteristic and monotonous music.

On Friday, September 9, after the President's address, Dr. Beddoe gave a summary account of the mediæval population of Bristol, based on two series of skulls, the one mediæval, the other probably of the eighteenth century, disinterred on the occasion of the removal of St. Werburgh's church, and on certain lists of surnames of various dates. He found the mediæval skulls very generally small, short and broad (cephalic index 80·0), while the later ones exhibited the same long types that characterise the present population of

Bristol and the surrounding districts (index 76·6). He ascribed the mediæval bráchycephalism to the large proportion of people of French descent, which was indicated by that of French surnames, these latter having gradually declined in number ever since the fourteenth century.

Prof. H. A. Miers, F.R.S., read a note on the origin of stone-worship, in which he pointed out that when meteorites fell in early times, they must have provoked religious awe; quoting instances among recorded falls in which this was certainly the case, and some in which the meteorite became an object of worship. Mr. Arthur Evans pointed out in reply that the meteoric theory of stone-worship had in fact been formerly dominant, but could not be held to account satisfactorily, in a large number of cases, for the observances associated with the worship of stones.

Prof. C. Lloyd Morgan gave a short account, with lantern illustrations, of the camps and megalithic remains to be visited during the meeting in connection with the excursions.

Mr. A. L. Lewis sent a note on the circles of Stanton Drew.

A description of the megalithic monuments of Dartmoor, by Mr. P. G. S. Amery, was postponed to Wednesday's session.

The afternoon session was held in the Princess Theatre, Park Row, and attracted an audience of nearly a thousand persons. Prof. E. B. Tylor, F.R.S., discussed the survival of palæolithic conditions in Tasmania and Australia, with especial reference to the modern use of unground stone implements in West Australia; pointing out that the stone implements from Tasmania, the making and use of which by the natives came under the observation of the colonists during the first half of this century, have a character which may be called quasi-palæolithic. They were fragments or flakes of stone, in no case ground, but edged by chipping on one face only, and trimmed so as to afford a grasp to the hand, no haft of any kind being used. These instruments correspond to some extent with scrapers, &c., belonging to the Drift and Cave periods in Europe; but their general rudeness, and the absence among them of symmetrical double-edged and pointed implements like the flint picks of Old World palæolithic times, place the modern Tasmanians at a distinctly lower stage than the Europeans of the mammoth period. The stone implements found in Tasmania, of which some good collections have now been made, indicate a state of the Stone Age in past times not essentially different from that found in actual existence before the disappearance of the native population. These quasi-palæolithic implements, old or new, have to be considered apart from the few cases of ground stone hatchet blades fixed in handles, which are now admitted to have been introduced in modern times by Australian natives.

The purpose of the paper was to offer evidence making it likely that the early Stone Age condition characterising Tasmania extended within no distant period over the whole Australian continent. A native Australian hatchet hafted with gum on a stick-handle was exhibited, lent by Mr. W. Ayshford Sanford, of Nynehead Court, Somerset, who brought it half a century ago from the Perth district of West Australia. The blade of this instrument, with its unsymmetrical edge formed by chipping along one side of the original flake, is simply indistinguishable from the ordinary Tasmanian form placed beside it. Prof. Tylor stated that, unwilling to judge hastily from a single specimen, he had for years been in correspondence with anthropologists in Australia as to the presence there of such implements, and had lately, through communications from the Bishop of Tasmania and Mr. Alexander Morton, of the Hobart Museum, received intelligence that the latter, than whom no one better understands the Tasmanian implement question, has on a late journey to the little-known Murchison district in West Australia, while not meeting with ground stone axes, found the natives using chipped stones quite similar to those used by the Tasmanian aborigines, as shown by photographs sent for comparison. These quasi-palæolithic implements not having yet been dispossessed in this district by the ground stone hatchets, which apparently were introduced from the Torres Straits region, it would seem that this neolithic invasion was of no remote date, and that the vast area including Australia as well as Tasmania may have been till then peopled by tribes surviving at a level of the Stone Age which had not yet risen to that of the remotely ancient European tribes of the Drift gravels and limestone caves. While disclaiming any hasty inference, Prof. Tylor called attention, from this point of view, to the importance of, and the similarities between, the modern Australioid skulls and the prehistoric skulls of Neanderthal, Spy, Padbaba, &c.

On Saturday, September 10, Prof. Tylor opened the morning session by introducing the final report on the north-western tribes of Canada. He pointed out that, while the work of the committee has materially advanced our knowledge of the tribes of British Columbia, the field of investigation is by no means exhausted. The languages are still only known in outline. More detailed information on the physical types may clear up several points that have remained obscure, and a fuller knowledge of the ethnology of the northern tribes seems desirable. Ethnological evidence has been collected bearing upon the history of development of the culture area under consideration; but no archæological investigations have been carried out which would help materially in solving these problems. For this reason Prof. Tylor thought it was a matter for congratulation to know that the ethnological investigation in British Columbia will not cease with the operations inaugurated by the committee, but was now entrusted to the committee for the ethnological survey of Canada, the second report of which was to be read during the morning. He finally bore testimony to the very high value of the work done by that committee.

Mr. J. L. Myres then read a condensed abstract of the complete final report of the committee. It consists of two parts: (1) Report of the investigations into the physical characteristics of the tribes of British Columbia, by Dr. Franz Boas and Mr. Livingston Farrand; (2) a summary of the work of the committee in British Columbia, by Dr. Franz Boas.

Sir John Evans, commenting upon the report, said that one question that arose was whether the committee had been able in the course of their labours to acquire any of those old personal objects which formed such an interesting subject in the report. He knew that in the museum at Victoria there was a collection of the antiquities of the north-western tribes of Canada, but he believed that the bulk of the objects collected in Canada were still in the museum of New York. This circumstance, however, was largely due to the greater liberality of the United States Government. It would be a graceful act if the authorities of that museum were to present to the British Museum a typical collection of the objects that Dr. Boas had obtained, assisted as he had been by the British Association. When in Vancouver and Victoria he had thought it a great pity that the many objects collected from the original inhabitants of the country had not found their natural home within the British dominions. Dr. Dorsey, he was sure, would agree with him that there was an abundance of material from which a selection could be made for the mother country. In conclusion, he asked those present to express their pleasure that the labours of the committee had terminated so satisfactorily.

Dr. G. A. Dorsey, of Chicago, stated that one of the objects of his present visit to England was to arrange for the transfer of some portions of the collection under his care to museums in England. He gladly testified, from his own practical experience, to the value of the reports of the committee as a guide-book to the tribes which they described. He further pointed out that Dr. Boas was not now in the service of any association, but was employed by the New York Museum, the directors of which had placed at Dr. Boas' command something like 1200*l.* for equipment purposes.

The President endorsed the views of Sir John Evans and Dr. Dorsey as to the value and importance of the work of the committee and its embodiment in the pages of the report.

Mr. Hartland expressed the hope that the whole series of reports, some of which are out of print, might be republished in a convenient form; and a resolution to that effect was subsequently sent up by the Sectional Committee to the Committee of Recommendations.

Mr. A. Krauss read a paper, illustrated by lantern slides, on the Tarahumare people of Mexico. He showed that the Tarahumaris lie in the most inaccessible portions of the Sierra Madre of Northern Mexico. They are ignorant and primitive, and many still live in caves. What villages they have are at altitudes of some 8000 feet above the sea level. They are a small and wiry people, with great powers of endurance. Their only food is pinoli, which is maize parched and finely ground. They have a peculiar drink called teshuin, also produced from maize and manufactured with considerable ceremony. The language of these hillmen is limited to about 300 words, and their imperfect knowledge of numbers renders them unable to count beyond ten. The religion they have seems to be a distorted and imperfect conception of Christian tradition mixed with some of their own ideas and superstitions. Miss Zelia

Nuttall summarised her own observations of the same peoples.

Miss Mary A. Owen contributed a note on the myths and customs of the Musquakie Indians.

Mr. C. Hill-Tout sent photographs of newly-discovered rock drawings from British Columbia.

The second report of the Committee of the Ethnographical Survey of Canada stated that the investigation presents two main branches: (1) that dealing with the white races, and (2) that dealing with the aborigines or Indians. These, however, are not entirely distinct, for a particularly interesting line of inquiry is that relating to the Métis or "half-breeds," resulting from the intermixture of the whites and Indians.

Three sets of anthropometric instruments have been purchased, and distributed to Mr. Charles Hill-Tout, of Vancouver; to Mr. A. F. Hunter, of Barrie, Ontario, who has associated with him Dr. F. Tracey, of Toronto; and to Dr. A. C. Hebbert, of Montreal. A camera, specially adapted to its work in the field, has been placed in the hands of Mr. Hill-Tout.

Communication has been opened with the Committee appointed by the American Association for the Advancement of Science for an Ethnographic Survey of the United States.

The several provincial governments of Canada have been approached for the purpose of obtaining, if possible, grants in aid of the work of the Committee. Nothing has, however, so far resulted from the communications referred to in the way of material aid; but Mr. David Boyle has been commissioned by the Government of Ontario to obtain photographs of the Indians of the province in connection with his investigations of Iroquois religious rites. Proceeding upon the lines adopted by Mr. B. Sulte in regard to the province of Quebec (whose results form Appendix II. of the Committee's Report), a similar inquiry has been undertaken by Mr. A. F. Hunter in regard to the composition of the population of the several counties of the province of Ontario. In British Columbia Mr. C. Hill-Tout has been able to do some work among the Haida Indians, and his results are presented in Appendix I.

On Monday, September 12, Miss A. G. Weld exhibited an early Cinghalese bronze image of Buddha, found in 1886 on the estate of Baltrasna, about 15 miles from Kells, by a labourer digging deep into a bog. Mr. C. H. Read accepted the image as a genuine work of Buddhist art, but quoted the frequent discovery of Chinese porcelain seals on Irish sites, which, like the figure in question, were probably not imported before the establishment of the tea trade. Sir John Evans pointed out that a bog would offer a safe place of concealment for stolen property. Dr. Beddoe stated that there was evidence, which was at least suggestive, that Buddhist missionaries did at some remote period reach these islands.

Mr. W. Crooke, late Director of the Anthropological Survey of the North-western Provinces and Oudh, read a paper on the jungle-folk and other Dravidians of Northern and Central India, describing the character of the country occupied by these races, their environment, food-supply and industries, and considering, mainly on the evidence of anthropometry, the relations between these jungle races and the peoples inhabiting the great northern plains. The suggestion that they were Mongoloid was dismissed as contrary to evidence recently collected. There was probably an original Negrito element in the earlier Indian races, but the existing traces of it appear hardly elsewhere than in the Veddas and the Todas. The existing Dravidians possibly represent a later emigration from the African continent, possibly reaching India by a route more northerly than that taken by the Negritos. In regard to the preponderate Dravidian element in the existing races, he briefly discussed the measurements collected by Mr. Risley and himself, and while generally accepting the conclusion that the effect of the Aryan invasion was more social than racial, he emphasised the need of a more extensive collection of measurements both on Indian soil as well as in Eastern Africa. He then proceeded to note survivals of primitive custom among the Dravidians. A discussion followed in which Dr. Beddoe, in conflict with Mr. Risley, asserted the existence of a considerable Aryan element among the present races.

Mr. Sidney Hartland desired to emphasise the value of the work done by Mr. Crooke in his inquiries among the races of the North-west Province and Oudh, and referred to the fact that ethnological work was positively discouraged among its officials by the Indian Government. Any one who realised the already very complex character of the facts relating to the native races, and the still increasingly complicated differentiation of new sub-castes and sections, must come to the conclusion that the amazing indifference of the Indian Government to ethnological questions was nothing short of suicidal. He would be glad if a representation could be made to the Indian Government urging the pressing importance to the Indian Empire of an exhaustive and sympathetic study of the races under its care.

The President heartily associated himself with the suggested appeal to the Indian Government.

An *ad interim* Report of the Torres Straits Anthropological Expedition was read, to the effect that Murray Island was reached on May 6, where, in the course of a fortnight, a number of anthropological and psychological observations were made. Delena was reached on May 27, and Port Moresby on May 31. In the absence of the Governor, Sir William Macgregor, Mr. Musgrave gave every assistance. Short visits were paid to Kaile, Kappakappa, Hula, Babaka and Kerepunu. Subsequently a short excursion was made to the Astrolabe Range. Drs. Rivers, MacDougall and Myers have obtained a large number of observations in experimental psychology, and the whole of the party have enjoyed good health.

Mr. R. E. Guise, in a paper on the tribes inhabiting the vicinity of the mouth of the Wanigela (Kemp Witch) River, New Guinea, described the tribes of Buláa, Kamali, Babaka, and Kalo.

Mrs. Isabella Bishop read an instructive paper on the Mantzu of Western Sze-Chuan. She entered upon the territory of the Tssu-Su of Goms and lived for some weeks among the Mantzu, being lodged either in their houses or on their roofs. She described the aspect of their villages and their dwellings, their devotion to Lamaistic Buddhism, their system of government, and their marriage and burial customs. Their most noteworthy characteristic was the position accorded to women, who were as unfettered as in England and America, and were on an absolute equality with men, possessing legal rights to property. She minutely described the dress and ornaments of both sexes, showing their occupations and amusements, and pointed out certain resemblances to the Lolos of Yunnan. They had their own language, but it was written in Tibetan characters. Their physiognomy was European in expression as well as feature, and recalled that of the Latin races. Mr. Archibald Little described some of his own experiences in the region, and characterised the inhabitants as being polite and hospitable. They seemed to be wedged in between China and Tibet; and how they came there appeared to be an ethnological puzzle, as their appearance was similar to the high-class Italian. Mr. Warington Smyth commented upon the characteristics of the country.

Sir T. Hungerford Holdich's paper on the Afridis and Swatis was postponed, owing to the serious illness of the author.

On Tuesday, September 13, Miss Mary H. Kingsley read a paper on West African conceptions of property, the object of which was to give some idea of the law and nature of property among the peoples of true Negro stock. The geographical distribution of the true Negro stock is a subject worthy of attention for several reasons. One is that among these peoples were found the most highly developed form of native African culture; another, that in the matters of physical and mental characteristics the true Negro differs greatly from the better-known Bantu stock. A high percentage of error had at present been attained by the failure to recognise these differences, and thereby the work of Sir A. B. Ellis on the true Negro, and that of Bastian on the true Bantu, had not yet been given its full scientific value. The three kinds of property existing in West African culture are (1) an ancestral property of the tribe ("stool" or "cap" property); (2) family property in which every member of the family had a certain share, to which every member had to contribute, and on which every member had a claim; (3) private property, acquired by personal exertion (over and above that made in co-operation with other members of their family) gained by gifts, or made in trade by the exertion of superior trading ability. Each of these kinds of property was equally sacred in the eye of native law. The only kind that could become another kind of property was the private. Stool property and family property remained of their kind for ever, and could not be alienated, though liable, with all the other kinds, to meet debt. Wealth was divisible into (*a*) the means by which property could be acquired and developed, to which division belonged wives and slaves; (*b*) property in power over market rights, utensils, canoes, arms, furniture, and trade goods. Property was guarded by and existed under the law represented by the cult of the law

god, and by the influence of religion. The President said that so elaborate a legal system, with such sound equitable principles, had seldom been brought before the Association. Sir William Crookes expressed his great admiration of the paper, and hoped that Miss Kingsley would read similar papers at future meetings.

Mr. H. P. FitzGerald Marriott then read a paper on the native secret societies of the West Coast of Africa. These societies maintained the religious and social principles of the people, and administered justice according to native law and custom. Some of them were merely temporary, such as the lesser Purroh of certain parts of Sierra Leone, of which white men spoke; others, again, were ancient tribal institutions, such as the secret religious or State Purroh, with its grand council, of which most people were unaware. Mahommedan influence was seen not only by the personal association of the latter, but by the knots that were used as charms both by some of these societies as well as by individuals. The names and varieties of these societies were numerous. Those nearest to each other were generally on good terms, though distinct; and all could be more or less connected. In various instances the Government could employ these societies to carry out its ends, and by means of methods to which the natives were accustomed could gradually habituate them to British law and order.

M. le Comte Charles de Cardi read a paper on "The natives of the Niger Delta," giving an account of the early navigators who visited Western Africa; of the origin of the Benin people and of many of their customs; of Ju-Juism in the delta, with some description of devil-huts; and concluding with an estimate of the capabilities and future of the West African natives.

Mr. C. H. Read contributed a paper, illustrated by a series of lantern slides lent from the collection of the Anthropological Institute, on "Ancient works of art from Benin city." He pointed out that the position of Benin near the great waterway of the Niger had brought it into contact with influences from the north. It was thus possible that here might be found some relics of the ancient civilisations of the Mediterranean. Relations with Abyssinia were founded on the journey of a Franciscan friar from Benin to Ethiopia in the fourteenth century, and some corroboration of this was found in the Benin tradition that the king was subject to a powerful prince far to the east. In the hope of finding evidence of these traditions in the loot that came from Benin, Mr. Read had made representations to the Government, with the result that a large collection of ancient examples of Benin art had been secured for the British Museum, though it could scarcely be said that they had any direct bearing on the relations of Benin with either the extreme north of Africa or the East. A document of great interest bearing on their origin was a report by Sir Ralph Moor, giving the account of a palaver with the Court historian, three Ju-ju men, the master smith, the master wood-carver, and the master ivory carver, from which it appeared that the white men first came in the time of King Esige, and one of them, named Ahammangiwa, made the plaques and brass-work for the King. Assuming an average reign of twenty to twenty-five years for each of the kings, this would bring the time of Esige to about 300 years ago, a date that would correspond very well with the date of the European costumes shown in the plaques.

Mr. C. W. Hobley sent some vocabularies and illustrative examples of the languages of Kavirondo. Copies of these are to be seen and consulted in the library of the Anthropological Institute.

In the afternoon Prof. Flinders Petrie gave a summary of the principal discoveries during the last five years that had revealed the rise of Egyptian civilisation. Various excavations at Koptos, Naqada, Abydos and Hieraconpolis had discovered remains belonging to the ages before 4000 B.C., which had hitherto been the starting point of known history. Beginning with the Libyan stock, with some Negro mixture, which occupied Egypt in its earliest civilisation, he showed some of the objects he had found at Naqada. These were at first temporarily assigned to a new race; but now they could be safely assigned to the pre-dynastic stock about 5000 B.C., and even earlier. In the graves of this aboriginal race were found bowls of black clay with patterns imprinted upon them. In each of the countries where this type had been found, it was contemporary with the introduction of metals. The proximate date of this was 5000 B.C.—and that accorded very well with the time necessary for arriving at the high culture attained by 1500 B.C. Therefore these discoveries were of great value in giving the relative state of Egyptian civilisation to that of the rest of the world at the introduction of dynastic rule. There was a wide difference between the people of 5000 B.C. and those of 4000 B.C., but no difference between those of the latter period and modern times. This showed that a different race entered the country about that period.

Next came the earliest dynastic remains, *e.g.* the presumed tomb of King Mena, the founder of the dynastic history, of about the date of 4700 B.C., then the remains of other royal tombs found at Abydos belonging to the first three dynasties. The gradual decay of flint working between 4500 B.C. and 1500 B.C., as metals came into use and copper was gradually hardened into bronze, had no parallel in the world. Prof. Petrie showed diagrams and impressions of cylindrical seals as used by the kings of the first three dynasties, also a vase exhibiting the earliest representation of Egyptian mythology and other vases, tablets, and slates showing animals and birds. These finds were very important, as they showed the rise of the art of modelling, and of the Egyptian ideas and appreciation of the forms of animals and of the human body, and proved that Egyptian art reached its high-water mark somewhere before B.C. 4000. Other finds showed the kings in triumph over their enemies, receiving captive kings, opening the public works, or reclaiming the marshes. The handled copper vessels showed the most advanced metal work found of the first three dynasties. The population of the pre-dynastic age was different in type from that of historical times, and in the early monuments the presence of diverse types was very clear. We had at last before us evidence of the close of the period previously considered prehistoric, showing the development of the art, writing, and civilisation of Egypt and the composition of a race which had since maintained its character during 6000 years. Egypt was then an originator in the arts and not a borrower, but ever since then most of the nations of the earth had been borrowers and not originators. Here we were studying the history of a country not borrowing but developing a vast and complex civilisation on its own resources.

Sir John Evans said that the wonderful flint knives must have been the culminating point of an art stretching over a vast series of years. Where was all that civilisation developed? He hoped that the recent conquests in Egypt would materially assist us in investigating that matter.

Mr. Arthur Evans thought a comparison of the pottery of other parts of the Mediterranean basin with that of Egypt helped to bridge the gap which separated early Egypt from the dawn of civilisation in Europe. He considered that Prof. Flinders Petrie would be safe in assigning his discoveries even to an earlier date than he had done.

Prof. Flinders Petrie, in reply, said that he himself thought that he was well within the mark, but he chose the date he had fixed in order to be absolutely safe.

Miss A. Goodrich Freer then read a paper on "The folk-lore of the Outer Hebrides." This folk-lore has a degree of interest which justified the inconvenience attendant on its collection. A peculiar value attaches to the ancient hymns, stories and legends, and to the charms, spells and divinations, because these were more certainly becoming difficult to recover.

On Wednesday, September 14, in the morning, the programme consisted of papers on archæology and folk-lore.

Mr. Sidney Hartland presented the sixth Report of the Committee on the Ethnographical Survey of the United Kingdom, emphasising the fact that, while the whole scheme of the committee's inquiries included a number of subjects, it was not considered necessary for each observer to deal with them all, and that some subjects, such as current traditions and beliefs, and dialects, were more immediately pressing than others.

Mr. A. Bulleid presented the third Report of the Committee on the Lake Village at Glastonbury. Twelve more dwelling mounds have been examined, as well as the ground between and around them, and the southern end of the settlement has now been completely explored, the timber substructure in this locality being in a better state of preservation than in any part hitherto examined. Mounds A, B, C and D showed the gradual growth of the village, easily recognised by the floor of one mound overlapping the floor of the mound immediately contiguous to it, also for the number of bone needles found. Mound E contained the remains of a small furnace of baked clay, fragments of crucibles, and small pieces of bronze. In Mound A A, part of the framework ostensibly of a loom was discovered; evidently discarded before the first dwelling was erected.

Mr. Arthur Evans supplemented this report with a paper on the place of the Glastonbury Lake Village in British archæology. He insisted upon the homogeneous character of the culture here revealed, and showed that it belonged entirely to the pre-Roman period and the first and second centuries B.C. It represented a distinct phase of a form of culture introduced into Britain by the invading Gaulish tribes. The glass-working industry of Glastonbury was probably derived, by the same overland route as various forms of vases, safety-pins, and other relics, from the old Venetian region] where this art flourished already in prehistoric times. The name Glastonbury itself was a translation of the Celtic Ynis-witrin—Glass Island.

Prof. Boyd Dawkins said that the inhabitants of that village had most probably introduced both glass-making and lead-mining. He had no doubt that Mr. Arthur Evans's derivation was correct. Sir John Evans thought that the mere fact of the dwellings being in that unsuitable position pointed to the probability that the constructors were lineally connected with other lake dwellers on the continent of Europe. That the occupation of the village ceased in the first century after Christ seemed probable, because of the general absence of Roman ware.

Prof. W. M. Flinders Petrie then read a paper on traces of primitive *Terramare* settlements in the modern towns of North Italy. He showed that recent clearing at Castellaro di Fontanellato had disclosed the fact that the marsh towns of North Italy in the Bronze age were arranged on a strictly square system of crossing roads, and that this type of town was perpetuated in the regular plan of the camps of the Roman army. On examining the present plans of the cities of Lombardy, the outline of the original square settlements could be plainly traced. Replying to the objection that the existence of square forms of towns did not itself prove that those forms were of pre-Roman date, Prof. Petrie said that that was not really his argument; granting or assuming the pre-Roman date, the square forms of the towns would indicate the presence of *Terramare* settlements.

Mr. P. F. S. Amery then exhibited, with explanatory remarks thereon, a series of lantern slides showing the megalithic monuments of Dartmoor, in anticipation of the Devonshire excursion arranged in connection with the Bristol meeting.

The Report of the Committee on the Excavations at Silchester stated that the area selected for excavation in 1897 included two *insulæ* (XVII. and XVIII.), extending from *insula* III. (which was excavated in 1891) to the south gate, and lying on the west side of the main street through the city from north to south. It is proposed during the current year to excavate the two *insulæ* south of *insulæ* XV. and XVI. (excavated in 1890), and a triangular piece of ground to the south of them, almost as large as a third *insula*. When the examination of this area is completed, considerably more than half the city will have been systematically excavated and planned.

Miss Nina Layard reported the discovery of human skeletons walled up in the remains of the Black Friars' monastery at Ipswich.

Mr. T. W. Shore read a paper on traces of early Kentish migrations. He identified such early Kentish colonies by Jutish or Kentish place-names under their present or more ancient form; by other place-names derived from the Jutish hero Hengest; by survival of gavelkind and customs of land tenure analogous to those of Kent, and of kindred customs.

Papers on the folk-lore of Guernsey, by the late Mrs. Murray-Aynsley, and on myths of insect life, by Mr. S. Clement Southam, were taken as read; and the session closed with a vote of thanks for the use of the Park Place Schoolroom, and with the exhibition in the Committee-room, by Mr. H. Bolton, of human relics from the recently discovered caves at Uphill.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A LETTER written by the Public Orator, Dr. Sandys, thanking Mrs. John Hopkinson and other members of her family for their munificent benefaction of 5000*l*. to the University of Cambridge, to be applied to the building of a memorial of the late Dr. John Hopkinson and Mr. J. G. Hopkinson, was read by Dr. Sandys in the Senate House, and approved by Grace of the Senate, on November 10. It has since been engrossed on parchment and presented to Mrs. Hopkinson.

Science announces that the late Edward Austin, of Boston, has given by his will 1,100,000 dollars for public purposes; 500,000 dollars is left to Harvard University, 400,000 dollars to the Massachusetts Institute of Technology, 30,000 dollars to Radcliffe College, 30,000 dollars to Roanoke College, and 30,000 dollars to the Tuskegee Normal and Industrial School. The income from these large bequests is to be used for scholarships. The sum of 10,000 dollars is also given to the bacteriological laboratory of the Harvard Medical School.

AT a conference on secondary education, convened by the Victoria University, and held on December 3 at Owens College, Manchester, resolutions were passed urging that (1) a Minister of Education of Cabinet rank should represent the Education Department in Parliament. (2) The consultative committee mentioned in Clause 3 of the Bill laid before the House of Lords last session should be obligatory. (3) Immediate provision should be made for the institution of local authorities for secondary education. Another resolution, to the effect that the relations of the proposed Board of Education to the Charity Commissioners should be more clearly defined in the Bill, was adopted.

A COURSE of about thirty-three lectures on "The Morphology and Histology of the Vascular System," commencing on January 11, will be given at University College, London, by the assistant professor, Mr. A. G. Tansley, each lecture to be followed by two hours' practical work or demonstration. An attempt will be made to trace the evolution of the stele of the vasculares through the various stages exhibited by pteridophytes and phanerogams. A special feature of this part of the course will be the inclusion of the important fossil types, many of which throw much light on the course of evolution of the vascular system, and whose anatomy has become fully understood only through the researches of the last few years.

SIR J. GORST, M.P., delivered an address to agriculturists at Cambridge on Saturday afternoon, on "Education in Agricultural Districts." In the course of his remarks, he said that reports showed that the chief reason for the prosperity of agriculture in foreign countries was the education of the people in all technical knowledge pertaining to their industries. If efforts were to be made to raise agricultural education in this country to something like the level of Denmark, France, or Switzerland, they had a very difficult task before them. Elementary education was the bed-rock upon which the whole of the superstructure must be built. It was useless to attempt a national system of technical instruction until there was a sound system of elementary instruction upon which it could be based.

THE Association of American Agricultural Colleges and Experiment Stations recently held a successful meeting at Washington, D.C. The following facts with reference to the Association and its work make a striking testimony of the condition of agricultural education and research in the United States: The institutions represented in this Association employ over 1500 persons in their faculties, who are giving instruction to about 30,000 students. These institutions have over 50,000,000 dollars in permanent endowments, buildings and equipment, and an annual revenue of nearly 6,000,000 dollars, of which more than 2,000,000 dollars is derived from funds granted by the United States. Besides the work of instruction, they are carrying on original research in different directions. This is especially true in many scientific lines relating to agriculture, over a million dollars being spent for this purpose annually. There are now pending in Congress propositions to establish, in connection with these institutions, experiment stations for investigations in mechanical arts and naval engineering, for which some of the colleges already have considerable facilities.

THE Chelsea Physic Garden is in future to be administered in accordance with an extended scheme. The *Pharmaceutical Journal* states that the Apothecaries' Society has decided, owing to considerations of expense, to abandon the management of the garden which, it will be remembered, was founded by Sir Hans Sloane in the early part of the eighteenth century, and was subsequently transferred to that Society in trust. A scheme has accordingly been drawn up for vesting the control in the Trustees of the London Parochial Charities, but it is proposed that the actual management should devolve upon a committee of fifteen members, eight to be nominated by the Trustees, and one each by the Treasury, the Lord President of the Council, the Royal Society, the Technical Education Board,

the Society of Apothecaries and the Royal College of Physicians in turn, the Pharmaceutical Society of Great Britain and the Senate of the University of London. It is intended that the existing garden should be fully maintained, a suite of rooms being provided for lectures and experimental teaching, whilst the Trustees are to be given authority, if they think fit, to erect and fully equip a physiological laboratory.

To carry out the new scheme referred to above, an annual income of eight hundred pounds is to be provided by the Trustees, and it is proposed in addition that the committee shall be furnished with such a capital sum as may be necessary to enable them to enforce the scheme to its full extent. The committee is to appoint a curator for the scientific supervision of the garden, and other members of the staff. Further, the committee will be authorised by the scheme to provide instruction in botany by means of lectures, demonstrations, &c., with special reference to the requirements of elementary education; to arrange for the maintenance of botanical collections of living plants for teaching purposes, and, so far as practicable, for the supply of botanical specimens for the purpose of external instruction. Students of institutions receiving aid from the funds of the City Parochial Foundation are to be eligible for admission without payment of fees; and it is provided that, so long as a yearly payment of not less than one hundred and fifty pounds is made to the Trustees out of the moneys provided by Parliament, students of the Royal College of Science shall also be admitted to the garden without payment, while they, the professors and teachers of the College, shall be entitled to the use of the garden, the botanical collections, and the lecture rooms for such time as may be approved by the Charity Commissioners. It will thus be seen that the scheme is of a far-reaching character, and calculated materially to increase the usefulness of the garden.

SCIENTIFIC SERIALS.

Memoirs of the Kazan Society of Naturalists. Vol. xxx.—On the oro-hydrography of the Nizhne-Isset mining region in Middle Ural, by V. Rozhkoff, with an orographic map in which the plateau character of the region appears very well.—On intra-cellular growths in cancer, by A. Rebrovsky, with a plate. Sporiferous growths were not found in cases unaccompanied by wounds.—On the parisitism of the Rotatoria *Notomatta Wernecki* in the Vaucheria, by W. Rothert, with a plate.—On the geology of the water-parting between the Volga and the Don at Tsaritsyn, by M. Yanischewsky. A large development of old Post-Pliocene alluvial deposits was found.—Water in wells at Kazan, by Prof. Scherbakoff.—On crystal-bearing cells in cork membranes, by W. Rothert. The observations of Zacharias, Cederwall, and Meyer are confirmed by observations on *Agave*, *Fourcroya*, *Drocaena*, and several others.

Vol. xxxi.—On the structure of the membrane of the vessels in plants, by W. Rothert, with a plate. A preliminary report on extensive researches ioto this question.—On the pathological and anatomic changes in organs and tissues resulting in raphania, ergotismus, and similar diseases, by N. Vinogradov, with one coloured plate. A detailed investigation of many cases of these diseases, which often assume in Russia an epidemic character.—On investigations of the soil, made in 1896 by R. Rispolozhensky. Part of a wide system of investigation which is being carried on for many years in Russia.—Chemical and physical researches into the soils of Kazan, by V. Sorokin.—The fauna of the upper parts of the Permo-Carbonic formations on the Kama and Chusovaya rivers, by N. Romanov. Eighty-nine species are described, the following being new: *Aviculopecten Stuckenbergi*, *A. parvulus*, and *Pleurotomaria fluctuosa*. The deposits belong to the Kungur division of Prof. Stuckenberg.

Bollettino della Società Sismologica Italiana, vol. iv., 1898, No. 4.—On the investigation of seismic periodicity by the method of overlapping means, by C. Davison. A description (in English) of a rough method of harmonic analysis suitable for the investigation of the annual and diurnal periodicity of earthquakes, with examples worked out in illustration of the method.—On the increase of activity presented by Vesuvius in the months of April and May, by R. V. Matteucci.—Notices of earthquakes recorded in Italy (September 1897), by G. Agamennone. A long and valuable series of records of three earthquakes, two of which originated at Labuan (Borneo) on September 20 and 21, and the third in the province of Ancona (Italy) on September 21.

Bulletin de la Société des Naturalistes de Moscou, 1897, No. 4. This volume contains one paper, "*De Aphodio scuticolli m. (nigrivitti, Rth.) ejusque cognatis*," in Latin, by A. Semenoff. The remainder is taken up with the proceedings, which contain a number of shorter notes, and the yearly report. During the year 1897 a considerable number of members of the Society, chiefly botanists, explored various parts of Russia.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 17.—"The Electrical Conductivity and Luminosity of Flames containing Vaporised Salts." By Arthur Smithells, H. M. Dawson, and H. A. Wilson. Communicated by Sir H. E. Roscoe, F.R.S.

(1) The authors conclude from their experiments, that the conductivity of vaporised salt is of an electrolytic character, but that there are features connected with it that distinguish it from electrolytic conduction in aqueous solution. Thus Ohm's law is only obeyed within certain limits, and the general relation between current strength and electromotive force can only be represented generally by a more complex expression.

(2) The conductivities of different salts differ greatly, according to the electropositive constituent.

(5) Among different salts of the same metal differences of conductivity appear at the higher concentrations, but at low concentrations equivalent solutions have equal conductivity.

(4) The conductivity of the haloid salts as a group is distinct from that of the oxy salts.

(5) The conductivity of the haloid salts of a metal among themselves increases with the increasing atomic weight of the halogen.

(6) The conductivity of the oxy-salts of a metal is approximately equal, and approaches that of the hydrates.

(7) The more easily oxidisable halogen salts are probably partly converted into oxide in the flame, so that their conductivity is composed of two parts.

(8) The behaviour of the salts in flames supplied with chloroform vapour seems to establish the fact that the conductivity and the colour produced by the salt vapour are not due to a common cause.

The coloration of a flame by an alkali salt does not seem therefore to be connected with the conisation of the salt. It must be attributed to the metal set free by a chemical process. This process consists probably in a reduction effected by the flame gases. An oxy-salt would, generally speaking, form in the first instance an oxide, which would then be reduced. In the case of haloid salts it seems also necessary to suppose that an oxide is intermediately formed, the metal being then liberated by reduction.

Physical Society, December 9.—Mr. Shelford Bidwell, F.R.S., President, in the chair.—Dr. C. Chree read a paper on longitudinal vibrations in solid and hollow cylinders. The ordinary formula for the frequency of longitudinal vibrations refers to an ideal rod of infinitely small section. This formula constitutes a first approximation, according to which the higher notes are exact harmonics of the fundamental note. Prof. Pochhammer, and Lord Rayleigh independently, over twenty years ago, arrived at a corrective term for solid isotropic rods of circular section, according to which the harmonic relation between the notes is no longer exact. During the last twelve years Dr. Chree has devoted several papers to the subject, confirming by independent methods the *results* obtained by Pochhammer and Rayleigh, and arriving at analogous results for other forms of section, and for material symmetrical round an axis but not isotropic. The first part of the present paper develops what appears to be a new method, based on expressions obtaioed some years ago by the author for the mean values of the strains in an elastic solid of any kind or shape, exposed to any system of forces. Besides confirming his previous results, Dr. Chree obtains new results applicable to material neither isotropic nor symmetrical round the axis of the rod. The second part of the paper treats of a hollow circular rod, or tube, of isotropic material. When the walls of the tube are thin, the correction to the ordinary formula is twice as large as for a solid

rod of the same diameter. The different methods all point to the conclusion that the ordinary formula supplies a close approximation to the truth only so long as the greatest diameter of the cross-section is small compared to the nodal interval in the rod.—A paper on the thermal properties of normal pentane, by Mr. J. Rose-Innes and Dr. Sydney Young, was then read. In 1894 the authors investigated the relations between the temperatures, pressures and volumes of isopentane, through a wide range of volume; the results are published in the *Proc. Phys. Soc.*, xiii. pp. 602–657. It is there shown that if a and b are constants depending on the nature of the substance and on the volume, the relation $p=(bT-a)$ at constant volume holds good with but small error from the largest volume (4000 cub. cms. per gramme) to the smallest (1·58 c.c. per g.). In the neighbourhood of the critical volume (4·266 c.c.), and at large and very small volumes, the observed deviations are well within the limits of experimental error, but at intermediate volumes they are somewhat greater. As they exhibit considerable regularity, it is a question whether they could be attributed entirely to errors of experiment. In any case, the above relation may be accepted as closely approximate to the truth. The present paper refers to a similar investigation on pure normal pentane obtained by the fractional distillation of the light distillate from American petroleum. The method employed for this separation is fully described in the *Trans. Chem. Soc.*, vol. lxxi. p. 442, 1897; the vapour pressures, specific volumes as liquid and saturated vapour, and critical constants are given in the same journal, p. 446. With regard to theoretical deductions from the present results, advantage is taken of the fact that a similar set of experiments had already been carried out with isopentane, which is an isomer of normal pentane. It was hoped that light would be thrown on the question of the influence exerted by difference of chemical structure on the thermal properties of a substance. The conclusion arrived at as most probable is that the coefficients of the second power of the density in the expansion of p must be different for the two substances. The slope of the curve obtained by plotting $(av^2)^{-1}$ against $v^{-\frac{1}{2}}$ suggests discontinuity somewhere about vol. 3·4, as with isopentane. Mr. Lehfeldt asked whether the authors had observed any other singularity or discontinuity at vol. 3·4. He also asked whether the authors were satisfied with ordinary squared-paper in plotting their curves. It ought to be possible to design a machine for doing the work mechanically to one-fiftieth of a *m.m.* accuracy. Mr. Appleyard said the fractionating apparatus devised by Dr. Young was a great improvement on older forms; it ensured that there should always be sufficient and yet not too much liquid at each valve-trap. He hoped that details of the tube, in its latest form, would be included in the paper. In the separation of such a mixture as chloroform and alcohol the common method by water-extraction was imperfect; it was not desirable always to convert the mixture wholly into chloroform. Ordinary fractionating tubes yielded an impure distillate in this case. Perhaps the difficulty was inherent for those two liquids. Dr. Young's apparatus would put the question beyond doubt. Dr. Young, in reply, said that the only objection to curve-tracers was their cost. The curves he had obtained from his experimental results were all isothermals: he did not think isobars would indicate anything such as Mr. Lehfeldt had suggested. With regard to such mixtures as chloroform and alcohol, the chances of separation were difficult to predict. A distinction might, however, be drawn between liquids partially miscible, and liquids miscible in all proportions. Hexane (b.p. 69° C.) and benzene (b.p. 80° C.) for instance, were both hydrocarbons miscible in all proportions, and it might be thought possible to separate them by a fractionating apparatus. But experiment shows they cannot so be separated. If alcohol and chloroform should turn out to be miscible in all proportions, the probability was that they could not, effectively, be fractionated; if, on the other hand, they prove to behave like partially miscible liquids, the separation by a fractionating apparatus such as he had described was rendered possible.—The President proposed votes of thanks to the authors, and the meeting adjourned until January 27, 1899.

Chemical Society, December 1.—Prof. Dewar, President in the chair.—The following papers were read:—The oxidation of polyhydric alcohols in presence of iron, by H. J. H. Fenton and H. Jackson. In presence of iron, methylic, ethylic, propylic, isopropylic and amylic alcohols are not oxidised by hydrogen peroxide; but vigorous oxidation of ethylene glycol, glycerol, erythritol, mannitol, dulcitol and sorbitol is effected by hydrogen peroxide in presence of, but not in absence of, ferrous salts.—The occurrence of hyoscyamine in the *Hyoscyamus muticus* of India, by W. R. Dunstan and H. Brown. The stem and leaves of *Hyoscyamus muticus* contain about 0·1 per cent. of hyoscyamine; the alkaloid can be extracted more readily from this plant than from henbane.—The comparative colour of the vapour of iodine in gases at atmospheric pressure and in a vacuum, by J. Dewar. By distilling and condensing iodine on a glass surface at −180° to −190° in vacuum test-tubes or bulbs, transparent films of iodine of varying thicknesses may be obtained. On enclosing pure iodine in half-litre flasks, a visible colour is imparted to the air, carbon dioxide, hydrogen or oxygen with which the flask is filled at ordinary temperatures; if the flask be evacuated, the colour of the atmosphere is markedly less, and this distinction remains even when the flasks are heated side by side on the water-bath.

Paris.

Academy of Sciences, December 5.—M. Wolf in the chair.—Contribution to the theory of the safety bicycle. by M. J. Boussinesq. A mathematical investigation of the equilibrium of the rider.—On the anomalous dispersion and magnetic rotatory power of certain incandescent vapours, by M. Henri Becquerel. In a previous paper the author has explained the unusually great rotatory power observed by MM. Macaluso and Corbino for radiations from sodium vapour in the immediate neighbourhood of absorption bands by regarding the phenomenon as one of abnormal dispersion. In the present paper experimental details are given of a method of making the sodium flame act itself as a prism. The spectrum from an electric arc, which has passed through this flame, shows discontinuities in the neighbourhood of the D-lines. The results form a complete explanation of the results of MM. Macaluso and Corbino, and are in agreement with the theoretical views previously put forward by the author.—On the velocity of sound in air, by M. J. Violle. A discussion of the objections raised by M. Leduc to measurements of the velocity of sound made in the open air. It is shown that the presence of moisture leads to a correction which is smaller than the experimental error of the measurements.—On the synthesis of phenol from acetylene, by M. Berthelot. This synthesis is of interest on account of the comparatively low temperature (200° C.) at which it can be effected. Acetylene is passed into fuming sulphuric acid, the liquid diluted, and the potassium salt prepared of the acid thus formed. This salt, submitted to a potash fusion at 180° to 220° C. for twenty minutes, the mass acidified and distilled; phenol is readily recognisable in the distillate. A repetition of the process upon the residue in the retort yields more phenol.—Action of acetylene upon the metal-ammoniums, by M. Henri Moissan. The metals (sodium, potassium, lithium, and calcium) were dissolved in liquid ammonia at −40° to −80° C., and pure acetylene gas passed in. The residues obtained after evaporation of the excess of liquid ammonia had the compositions, respectively, of $C_2Na_2.C_2H_2$, $C_2K_2.C_2H_2$, $C_2Li_2.C_2H_2.2NH_3$, $C_2Ca, C_2H_2, 4NH_3$; all these compounds dissociate on heating, leaving the corresponding carbides, C_2Na_2, C_2K_2, C_2Li_2, C_2Ca.—The colour of calcium carbide, by M. Henri Moissan. Absolutely pure calcium carbide is transparent and colourless; the presence of a minute trace of iron is sufficient to give it the reddish brown colour of the material obtained by the electric furnace.—On the properties of aluminium, by M. A. Ditte. Aluminium is readily attacked by many chemical reagents, acids, alkalies and salts; but in many cases a protecting layer of gas or oxide is formed, so that little or no action takes place in cases where thermochemical data would lead to the prediction of a very energetic attack. Circumstances which destroy this film, lead to rapid solution of the aluminium.—Histology of the skin, by M. L. Ranvier. A study of the fatty matter of the corneal layer of epidermis in man and other mammals.—The liver as a pigmented organ in the Invertebrates, by MM. A. Dastre and W. Floresco. A comparison of the differences and similarities of the hepatic organs in Vertebrates and Invertebrates.—On the prediction of the occultations of stars by the moon, and on the calculation of terrestrial longitudes by means of occultations, by M. G. Bigourdan.—Numerical results obtained for the latitude of the Observatory of Paris by observations made on the garden meridian circle, by MM. H. Renan, J. Perchot, and W. Ebert.—On the determination of gravity on the summit

of Mont Blanc, at Chamonix and at Meudon, by M. Hansky.—On differential equations of the second order with fixed critical points, by M. Paul Painlevé. —On the singular points of a function defined by a Taylor's Series, by M. Le Roy.—On the reduction of multiple integrals, by M. Ch. J. de la Vallée Poussin.—On a new phenomenon exhibited by light in traversing certain metallic vapours in a magnetic field, by MM. D. Macaluso and M. O. Corbino. A discussion of the theory advanced by M. Henri Becquerel.—Remarks by M. Becquerel on the preceding paper.—Absorption in a magnetic field, by M. A. Cotton.—Comparative study of the Hertzian field in air and in water, by M. Albert Turpain.—The Blondel-Carpentier hysteresimeter and its application to the statical measurement of hysteresis, by M. A. Blondel. The paper is accompanied by diagrams of the apparatus. Measurements made by the ballistic method were in close agreement with the readings of the instrument.—On the transmission of sound by a wire capable of conducting electricity, by M. Dussaud.—Displacement of metals by hydrogen, by M. Albert Colson. Dry phosphate of silver absorbs hydrogen in the dark and at 12° C. with production of free silver and phosphoric acid. This change goes on more rapidly when the temperature is raised. Silver pyrophosphate, sulphate, and oxide behave similarly.—On the combination of acetone with mercuric sulphate, by G. Deniges. The compound formed has a very high molecular weight, and contains only one-seventeenth of its weight of acetone. Hence it is a suitable means of detecting and estimating small quantities of acetone.—Action of hydrocyanic acid upon epichlorhydrin, by M. R. Lespieau.—On the development of the dilator muscle of the pupil in the rabbit, by M. Ed. Grynfellt.—On the digestion of starch in plants, by M. Leclerc du Sablon.—Elective absorption of some mineral elements by plants, by M. E. Demoussy. If nitrates and chlorides are simultaneously at the disposal of a plant, nitric nitrogen is absorbed in preference to chlorine.—Chlorophyll assimilation in terrestrial orchids, and in particular in *Limodorum abortivum*, by M. Ed. Griffon. Terrestrial orchids, considered from the point of view of carbon assimilation, are intermediate between plants such as *Epipactis*, in which carbon is taken from the air, and colourless species like *Neottia* and *Corallorhiza*, which are entirely saprophytic. In *Limodorum*, in spite of its richness in chlorophyll, its respiration of carbon dioxide is always greater than its assimilation.—On the toxic powers of chromium compounds with respect to the higher plants, by M. Henri Coupin.—On a new cupric broth, specially designed to combat the black rot, by M. Joseph Perraud. The addition of colophane imparts to the mixture great adhesive power and resistance to washing off by rain.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 15.

ROYAL SOCIETY, at 4.30.—(1) Application of Liquid Hydrogen to the Production of High Vacua, and their Spectroscopic Examination; (2) The Boiling Point of Liquid Hydrogen under Reduced Pressure: Prof. Dewar, F.R.S.—Ionic Velocities: Prof. O Masson.—Note on the Densities of Atmospheric Nitrogen, Pure Nitrogen, and Argon: Prof. Ramsay, F.R.S.—The Preparation and some of the Properties of Pure Argon: Prof. Ramsay, F.R.S., and Dr. Travers.—Observations on the Anatomy, Physiology, and Degenerations of the Nervous System of the Bird: Prof. Rubert Boyce and Dr. W. B. Warrington.—The Action of Magnetised Electrodes upon Electrical Discharge Phenomena in Rarefied Gases. Preliminary Note: C. E. S. Phillips.—On the Reciprocal Innervation of Antagonistic Muscles. Fifth Note: Prof Sherrington, F.R.S.

LINNEAN SOCIETY, at 8.—Sketch of the Zoology and Botany of the Altai Mountains: H. J. Elwes, F.R.S.—A Description of some Marine and Freshwater Crustacea from Franz Josef Land, collected by W. S. Bruce, of the Jackson-Harmsworth Expedition: Thos. Scott.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

CHEMICAL SOCIETY, at 8.—The Interaction of Ethylic Sodiomalonate and Mesityl Oxide: Dr. A. W Crossley.—Derivatives of Camphoric Acid. Part III.: Dr. F S. Kipping, F R.S.—Synthesis of $\alpha\beta\beta$ Trimethylglutaric Acid: H. Perkin jun., F.R.S., and Dr. J. F. Thorpe.

FRIDAY, DECEMBER 16.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Kentish Town Widening, Midland Railway: Walter Daniel.

QUEKETT MICROSCOPICAL CLUB, at 8.

TUESDAY, DECEMBER 20.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Paper to be further discussed: The Ventilation of Tunnels and Buildings: Francis Fox.——And, time permitting, Paper to be read with a view to discussion: High-Speed Engines: John Handsley Dales.

WEDNESDAY, DECEMBER 21.

GEOLOGICAL SOCIETY, at 8.—On a Megalosauroid Jaw from Rhætic Beds near Bridgend, Glamorganshire: E. T. Newton, F R.S.—The Torsion-Structure of the Dolomites: Dr M. M Ogilvie (Mrs. Gordon).—The Oceanic Deposits of Trinidad, W I.: Prof. J. B. Harrison and A. J. Jukes-Browne.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The West Indian Hurricane, September 1898: Captain A. Carpenter, R N.—The Connection between the Winter Temperature and the Height of the Barometer in North-Western Europe: W. H. Dines.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Binocular Microscopes.

THURSDAY, DECEMBER 22.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Telegraphy by Magnetic Induction: S. Evershed.—The Discussion on Dr. Lodge's Paper (Improvements in Magnetic Space Telegraphy, and on Mr. Evershed's Paper, will be opened by Dr. Fleming and Mr. Preece, with Experimental Demonstrations.

BOOKS and SERIALS RECEIVED.

BOOKS.—Wild Life at Home: R. Kearton (Cassell).—The Way the World went then: I. Barclay (Stanford).—Preliminary Report of an Investigation of Rivers, &c., of Ohio (Cleveland, Ohio).—The Witwatersrand Goldfields Banket, and Mining Practice: S. J. Truscott (Macmillan).—Zoological Record, Vol. xxxiv. (Zoological Society).—Lecture Notes on the Theory of Electrical Measurements: Prof. W. A. Anthony (Chapman).—Elements of Sanitary Engineering: Prof. M. Merriman (Chapman).—Manual of Determinative Mineralogy: G. J. Brush, 15th edition (Chapman).—The Annals of Mont Blanc; C. E. Mathews (Unwin).—Michael Faraday: Prof. S. P. Thompson (Cassell).—The Life Story of the late Sir Charles Tilston Bright: E. B. and C. Bright. 2 Vols. (Constable).—An Experimental Course of Chemistry for Agricultural Students: T. S. Dymond (Arnold).—Annalen der Sternwarte in Leiden, Siebenter Band (Haag, Nijhoff).—A Cotswold Village: J A. Gibbs (Murray).—Earth Sculpture: Prof. J. Geikie (Murray).—Marine Boilers: L. E. Bertin, translated and edited by L. S. Robertson (Murray).—Who's Who, 1899 (Black).—Band of Mercy, Vol. xx. (Partridge).—Animal World, Vol. xxix. (Partridge).—Annuaire, 1899; par le Bureau des Longitudes (Paris, Gauthier-Villars).—The Purification of Sewage: Dr. S. Barwise (Lockwood).—British Journal Photographic Almanac, 1899 (Greenwood).—An Atlas of Bacteriology: C. Slater and E. J. Spitta (Scientific Press).—Flashlights on Nature: Grant Allen (Newnes).—Knowledge, Vol. xxi. (High Holborn).

SERIALS.—Journal of Botany, December (West).—Geographical Journal, December (Stanford).—Zeitschrift für Wissenschaftliche Zoologie, lxv Bd. 1 Heft (Leipzig).—Catalogus Mammalium: Dr. E. L. Trouessart, nova editio, fasc. 4 and 5 (Berlin, Friedländer).

CONTENTS.

THURSDAY, DECEMBER 22, 1898.

GEGENBAUR'S COMPARATIVE ANATOMY OF THE VERTEBRATA.

Vergleichende Anatomie der Wirbelthiere: mit Berücksichtigung der Wirbellosen. Von Carl Gegenbaur. Erster Band. Einleitung, Integument, Skeletsystem, Muskelsystem, Nervensystem und Sinnesorgane. Mit 619 Zum. Theil farbigen Figuren im Text. Pp. xiv + 978. (Leipzig: Wilhelm Engelmann, 1898.)

THE first volume of the long-expected work by the master has appeared. By placing the study of anatomy upon the basis of evolution he had become the founder of modern comparative anatomy, and he has raised the building to a great extent by his own hands, supported by a school of disciples, ever increasing through his stimulating and correcting influence.

No wonder that for years expectation has been keen about this book, which must necessarily be the crowning of his life's work. The present volume, besides an introduction, deals with the tegumentary, skeletal, muscular and nervous systems, and the sense organs.

It would be a hopeless attempt here to give anything ike an adequate *résumé* of the nearly 1000 pages of this first volume. Only some of the salient features can be touched upon. The plan is grand; the execution can be fully appreciated only by those who have made comparative anatomy their special study, because the treatment frequently soars to such heights that the enormous amount of detail which is marshalled in the book, almost seems to disappear before the generalising ideas into which the facts have been welded and condensed. This is especially the case with the introductory chapters prefacing, or the summarising retrospects following upon, the principal chapters. But this does not make easy reading, and some of the sentences, although containing beautifully conceived ideas, are so idiomatic and so terse as to appear almost oracular. For instance, he discusses the development of the bird's wing, how the quills growing upon the patagium, and gaining preponderance over it, have become the functional wing surface, while the patagium itself loses its importance and becomes correspondingly reduced. The result of this contemplation is summed up thus: "Das Product tritt functionell an die Stelle des Bodens, auf dem es entstand."

The general introduction alone, taking up the first seventy pages, is an ideal treatise of morphology, dealing with such fundamental questions as adaptation, correlation, differentiation, inheritance, ontogeny with reference to phylogeny, value and meaning of the germinal layers, &c.

A characteristic feature, going like a red thread through the whole book, is the animosity against ontogenetic research so far as that is in the hands of those whom our author speaks of as embryographers. According to him the ontogenetic record is of no use unless it is in full concord with the results arrived at by the comparative anatomical method, and not many opportunities are missed which afford a stab at ontogeny where this has failed to elucidate a certain problem. The embryographer will, therefore, feel inclined to smile when he comes across the not unfrequent passages where, palæontology remaining mute and comparative anatomy revealing nothing, the problem in question is summarily dismissed as one fit for the ontogenetic method.

Another leading feature is the striving to derive any given organ from something else, from another one previously existing, instead of being satisfied with its origin *in situ*. Of course this is the true scientific, evolutionary method, and it is the very one by which Gegenbaur's works have become epoch-making; but occasionally the idea seems to be a little overdone, and it is then not always easy to reconcile the various arguments with each other. For instance, in the discussion of great importance, pp. 590-592, which runs approximately as follows:

It is more reasonable to derive cartilaginous parts from other existing cartilage, although their ontogeny may show them to make their appearance where they are wanted in the organism. Thus it is, for instance, preferable to assume the derivation of the Cyclostomes' gill-basket from the cranial cartilage, instead of believing that this basket-work has originated *in situ*. "It is (p. 590) very probable that the whole of the cartilaginous skeleton took its origin from the perichordal cartilage."

All this is certainly very satisfactory and uniform, but as the author himself has pointed out on p. 200, it is becoming more and more plausible that the original home of cartilage was in the integument, in the ectoderm. Its appearance in the perichordal neighbourhood would in this case be a secondary feature, owing to chondroid infiltration into the connective tissue. But if this is so, then there would be nothing unreasonable in the assumption that the gill-basket of the Lamprey had received its cartilage *in situ*. We do not want to press this derivation, but it seems unfair categorically to ask (p. 591):

"What business has a cell, or even a group of cells, to transform itself here or there into cartilage? One or a few cells, even when they become cartilaginous, do not yet possess a supporting function; at any rate the causal momentum of this transformation would remain obscure, as the result of the transformation cannot at the same time be its cause."

This certainly sounds very uncompromising, but the mystery of the origin of the cartilage is not solved by deriving it from other cartilage. The same consideration applies to the derivation of bone, and our author makes the following statement, p. 594:

"Indem wir das knöcherne Skelet nicht mehr ausschliess lich vom Bindegewebe ableiten, durch an sich unverstaendliche, weil in ihren Causalmomenten nicht darzulegenden Veraenderung en jenes Gewebe an den betreffenden Orten entstanden unsvorstellen, sondern den wesentlichsten Antheil bei seiner Entstehung in den Osteoblasten finden, werden die ersten Anfaenge der Hautskeletbildung (Selachier) mit den hoechst verwickelten Zustaenden des Skeletes der Wirbelthiere aufs innigste verknüpft."

The sentence just quoted, rather typical of the style, defies direct translation, but its sense may perhaps be rendered as follows: By referring the most essential share in the formation of the bony skeleton to the osteoblasts, we are enabled to connect intimately the first beginnings of the dermal skeletal formation (of Selachians) with the highly differentiated condition of the skeleton of the higher Vertebrata. We no longer derive

the bony skeleton exclusively from the connective tissue, and we no longer imagine that these tissues arose *in situ*, owing to changes which, as their causes cannot be explained, are by themselves not understandable.

In connection with the above consideration may be mentioned the following important views (p. 152): Although treated as an hypothesis, it appears likely that enamel, dentine, bone substance, are all of ectodermal origin, and the same is probably the case with cartilage. And p. 200: There are reasons for assuming, although not yet absolutely sure, that the whole mass of the placoid scale, including the bone, arises from the ectoderm. Anyhow, all the hard structures, and all their bony formations are derived from the integument. In the higher creatures the bone-forming material is already mixed up with the mesoderm, and our author thinks that the perichondrium has received its bone-forming elements likewise from the integument.[1] Some skleroblasts are certainly identical with osteoblasts, and these latter become eventually bone-corpuscles.

Anyhow, at last, the bugbear of the fundamental difference between tegumentary (so-called secondary, in reality primary) and chondral bone, and that between endo- and ecto-chondral bone, is recanted. Gegenbaur himself had introduced these differences, which have been used for the last thirty years as an all-powerful conjuring formula. He has laid the ghost originally raised by himself; laid perhaps too effectively, as the old terms could easily be made to receive a corrected meaning, in harmony with the old well-meant distinction, if—instead of primary and secondary bones in the old sense—we put primary and secondary elements of the primordial skeleton.

The author (p. 186) is in favour of the connection of the so-called notochord (which he would rather not straightway call a notochord) of Cephalodiscus, Rhabdopleura and Enteropneusta, with that of the Tunicates. The lucid treatment of this important structure may be used as an example of how the conditions prevailing among Invertebrata can be made to throw light upon the more complicated Vertebrata. He argues, namely, as follows:

"The origin of the chorda from entoderm, from the gut-wall, is phylogenetically not understandable. Such a string of cells must originally have had another function than that of support. It is therefore reasonable to derive the chorda from some gut-diverticulum, such as actually does exist at the very place whence phylogenetically the chorda must have begun; the diverticulum, as well as the chorda arising, moreover, at the spot where ento- and ecto-derm meet. And although such diverticula no longer exist in Tunicates, their ancestors must necessarily have possessed them, because some of the recent Tunicates have a chorda. Moreover, the occurrence of such diverticula in several otherwise divergent forms, as, for instance, Cephalodiscus and Rhabdopleura, indicate a former, more widespread existence."

All this is very satisfactory, but how does it fit in with what we read further on about the brain and the spinal cord?

[1] It is difficult to see how this tegumentary origin of cartilage (for which also see p. 152) can be reconciled with the statement made on p. 241—"An additional argument against the exclusive origin of cartilage from mesoderm is the transformation of chordal into cartilage cells"—even if this so-called chordal cartilage had not been shown by Zykoff and others to be an erroneously interpreted observation.

Gegenbaur, namely, has always held that the brain is the older, and the spinal cord the newer formation. Considering the importance of this question for the origin of the Vertebrata from Invertebrata, we turn eagerly to what he has now to say on this point. But instead of receiving comfort, we are led into a maze. See for this the following three statements:

(P. 724.) The phylogenetic value of the ontogenetic mode of origin of the spinal cord, namely, as a further continuation, or budding, from the brain, can be contested. Because such a mode of formation would presuppose a condition in which the spinal cord had preserved its ectodermal position in the ancestors of the Acrania. Only the epichordal nerve-string of the Tunicates represents a sort of early stage of the spinal cord, but in reality it is not yet a spinal cord.

(P. 725.) Exclusively ontogenetic treatment of this question shows that the spinal cord is phyletically produced by a successive budding from the archencephalon. But if this were really so, then the otherwise so well-founded connection with the Tunicates would disappear. . . .

On p. 779 the author holds that the mode of formation of the cord in Petromyzon and in Teleostei, as a solid string with subsequent appearance of a central canal, is more primitive than the early formation of a semi-canal of the medullary plate as observed in all the other Vertebrata.

These three statements are not easily reconciled, and that ontogeny supports the budding mode is an assertion at least surprising. But behold, on p. 718 and p. 719, concerning Tunicates, we are told that:

"Die Medullarplatte senkt sich in die Tiefe, besonders hinten, wodurch eine Taschenform entsteht. Die nach vorn sich weit oeffnende, hinten geschlossene Tasche erstreckt sich immer weiter nach hinten, indess ihre aeussere Oeffnung sich verengt, und als Neuroporus weiter besteht."

At first sight the reader will think that *nach hinten* is a *lapsus calami*, instead of *nach vorn*, but this is not the case. The sentence also reads as if neuropore and blastopore were the same, but a few lines further on we are categorically informed that certain other features, for instance the neurenteric canal, "are cenogenetic, and have to be passed over." In fact the author translates into growth backwards what ontogeny clearly shows to be the opposite, namely, the closing in of the canal from the blastopore forwards. Consequently the secondary nature of the spinal cord, as a budding from the brain, receives no support from ontogeny, while according to the author himself it can be contested upon phylogenetic grounds!

For the rest we cannot do more than single out a few paragraphs as samples, be they typical illustrations of the masterly treatment of the whole work, or be they falling short of, or running contrary to, our expectations.

The author emphasises the great difference between Sauropsida and Mammalia, and as we read further through the book all the differences are made much of, until the only group worthy of possible ancestral relationship are the Amphibia, notably Anura. This old view has been revived, and it is difficult to say if this unfortunate notion of Amphibian descent "mit Umgehung der

Sauropsiden" is a conclusion arrived at from structural grounds, or if it in turn is responsible for the acceptance of certain morphological conclusions. One, out of many, is the sanction given to the startling attempt made by his prosector, to derive the hair from something older than Sauropsidan structures, namely, from certain degenerating sense organs of Amphibia. A very able criticism of this hypothesis has, by the way, been given by Keibel in Merkel and Bonnet's periodical. The same idea of relationship underlies the treatment of the skin-glands, the skeleton of the limbs, the homologies of the ear-bones, &c.

The paragraphs dealing with the vertebral column are not a success; the question is left where Klaatsch left it in 1895, and that does not go beyond the cartilaginous fishes; the rest is written on the old futile lines. Nor can much praise be bestowed upon the treatment of the ribs, in which—instead of his old well supported teaching—a compromise has been made adopting the view of the existence of upper and lower ribs, mixing up thereby true ribs and other parts, which, although likewise differentiations of ventral arches, are not, nor ever were ribs. At the same time there is a tenacious pleading for the correctness of his original view. One of the causes of this uncertain state is the wholesale adoption of the results arrived at by one of his assistants.

Perhaps all through the book an easily understood, but nevertheless somewhat undue preference is given to papers published in the *Morphologische Jahrbuch*. Herewith is connected a peculiar treatment of the literature, which shows many deficiencies, more due to design than to accident, because the author says pointedly that he has restricted himself to the most important writings. Anyhow, this may be said in explanation: The MS. seems to have been practically finished several years ago, and little notice has been taken of what has been published since, except the work done by those with whom the author has been more or less in contact, bringing thereby some additions down to even last year's publications.

The genesis of the Chelonian carapace is a most suggestive chapter, but difficult reading, especially since, a page or two further on, the right of existence of an alternative view is conceded, namely, that neural and costal plates may after all be of dermal origin. Dermochelys, in support of the leading view in the text, is pronounced to be a low, most primitive form, but a little further on the mosaic shield of this turtle is confessed to be in a state of retrogression.

The visceral, branchial skeleton of the Cyclostomes (p. 415) is of ectodermal origin. "It must, however, have been derived from the cranial cartilage, for we cannot possibly side with the old teleological notion that this cartilage arises in the ectoderm *in situ* of the future branchial skeleton, and develops itself into the necessary branchial arches. A small interbranchial bit of cartilarge, consisting perhaps of a few cells only, would be of no use, and, moreover, why should such isolated bits of cartilage cells turn up there? But the assumption that the branchial apparatus arises as little processes of the already existing cranium, gives them at once a supporting function." Then follows a beautiful, lucid description of the branchial skeleton of the Gnathostomata, the whole long chapter, from Elasmobranchs to the highest Mammalia, with all the marvellous modifications, ultimately into hyoid, epiglottic and laryngeal apparatus being welded into an harmonious illustration of onward evolution.

On p. 460, in winding up with a fascinating *résumé* concerning the emancipation of the head from the rest of the body, the author takes the opportunity of severely reproaching the embryologists.

"Comparison teaches us that the visceral arches of the Amniota are derived from branchial arches; the descriptive method reveals only the differences, and takes no stock of the fact that these gill-less visceral arches were once gill-bearing arches. This knowledge is the result of the comparative method and of conclusions based upon these facts, conclusions which stand in contradiction to ontogenetic experience. But while this has not prevented any one from acknowledging the homologies of visceral and branchial arches, the same kind of conclusion when applied to the cranium [namely, to its metameric origin] meets with objections."

But was this outburst necessary? Who, having followed the last ten years of extremely active, and chiefly embryological research, does now object to the metameric composition of the head?

Curiously enough, his famous theory of the origin of the limbs and their girdles from visceral arches is only sketched in the very outlines. He devotes but a few very critical remarks to the important support, which his theory has gained from ontogenetic research, and how far ontogeny can be expected to yield results. This is surprising, because nobody, unless he has studied the whole question and the literature attentively, will be convinced by the perusal of the few pages 461–466. We had the right to expect a critical marshalling of the whole apparatus of comparative anatomy, with the numerous points in favour, drawn from the skeletal, muscular, and nervous systems, and refutation of the almost equally numerous mistaken contrary comments. The derivation and evolution of the free limb is, however, done splendidly, although we miss a discussion of the axis of the dactyloid limb. The author himself says, in the preface, that he could not treat everything with equal fulness, but there are not a few points on which we should have liked this very authority's opinion. We look, however, in vain for more than a passing remark under epitrichium, subnotochordal rod, proatlas, pisiform bone, os acetabuli, &c. He holds that there were never more than five fingers "unless a creature can be shown which normally possessed more." All the so-called vestiges of additional fingers and toes are discarded summarily; but might not Kükenthal's discovery of excalation of fingers in the Cetacea have been given at least passing consideration?

More than 100 pages are devoted to the muscular system, making quite a new feature in a text-book, considering how scantily it had been treated hitherto from a general point of view. It is the first successful attempt to bring the mass of accumulated observations into one frame, beginning with the invertebrate conditions as the fundamental starting-point, and then paying especial attention to the muscles of the head, and to the derivation of those of the limb from the truncal system. The nerve-supply is of course taken as the guide, while the almost

endless modifications are in many cases followed back to more primitive conditions. It is scarcely necessary to say that Gegenbaur himself initiated this treatment, culminating in the elaborate researches of Fuerbringer and Ruge.

The grouping of the cranial nerves is also quite new, but any attempt to arrange the cranial and cranio-spinal nerves without reference to their origin in the central ganglionic columns, must needs lead to failure ; and that is the case here. The metamerism of the cranial nerves implies a problem which is not only morphological but essentially physiological, and here was a chance for the morphologist to join hands with his physiological brother, instead of the usual complaint about the abstaining attitude of the latter, and absolutely ignoring his histological and experimental work.

Whilst discussing the modifications of the visceral arches, concerning the formation and the homologies of the ear ossicles (this vexed question has entered a new phase, far from being at rest), he makes the following remark : "Although none of these cases [certain reptilian modifications] are immediate preparations for the mammalian condition, they nevertheless appear as attempts towards this new modification." This is by no means the only instance of his speaking of attempts, or preparations, precocious and aborted, anyhow unsuccessful in one group, foreshadowing arrangements in others ; *e.g.* bipedal gait of Dinosaurs with reference to birds.

The last 127 pages are devoted to the sense organs. After a masterly general introduction follows a most interesting chapter on the organs of the "Hautsinn," taste, ear, eye, nose, each with an invertebrate prolegomenon, full of descriptive detail and all turned into a broadly conceived, well composed and carefully finished picture.

There is no book like this one on comparative anatomy. In broadness of plan, depth of conception, and critical execution it cannot be surpassed. Instead of being a fund of detailed facts, as some of its predecessors, it is a mine of wealth of most suggestive ideas.

If we have in some respects found fault with the book, the explanation suggests itself that the architect and master-builder has too trustingly taken over his material as sound and flawless from the bricklayers, carpenters, and other helpers. But the partial disappointment may also perhaps be a fault of our own, of those who expected too much from their old master, whom they look up to with a gratitude and reverence bordering on veneration.

H. GADOW.

ELEMENTARY QUANTITATIVE ANALYSIS.

An Introduction to Practical Quantitative Analysis. By H. P. Highton, M.A. Pp. 211. (London: Rivingtons, 1898.)

MR. HIGHTON appears to belong to the growing class of teachers of chemistry who believe that the practical work of beginners should be of a quantitative character. Qualitative analysis may, it is true, be made an excellent drill ; it attracts most young students, and its practice, if it be properly taught, undoubtedly promotes the formation of orderly habits, develops the powers of observation, and encourages the use of the reasoning faculties. But if it be ill taught, few studies are of less value.

It has been pointed out again and again that when the classes are large and the teachers few, when the available time for study is brief, and if the students come unprovided with a fair elementary knowledge of chemistry qualitative analysis is sadly apt to degenerate into the futile pursuit known as test-tubing. Moreover, this branch of work does not offer a very good selection of clear and simple illustrations of the fundamental laws of chemistry ; and it is these, after all, which we especially want to impress upon the minds of those young students who learn chemistry for the sake of its educational effect, and not, at first, in order to become chemists.

These and other similar considerations, as we all know, have led many schoolmasters to postpone qualitative work to a later stage than that at which it was formerly commenced, especially in schools where it is the practice to turn whole classes of young boys into the laboratory, instead of making them listen to lectures of a more or less formal and didactic character in the lecture-room, according to the older practice. It is natural, therefore, that of late years many attempts should have been made to produce a book suited to the needs of the juniors of to-day, as the "Small Roscoe" and "Little Miller" provided for those of earlier generations, in the times when the number of school laboratories might have been counted on the fingers of a single hand. And although nothing seems yet to have been produced which exactly supplies the existing need, several of the new books have been helpful and suggestive.

Mr. Highton's little book certainly takes rank with this latter class. It contains eighty-six carefully selected experiments, which have all been performed by boys in the Rugby Laboratory. These eighty-six experiments cover a fairly wide field, they are clearly described and illustrated by a number of helpful diagrams, they include several exercises in those parts of physics which are of the most direct importance to students of elementary chemistry, and several of them are quite easy ; but their character as a whole suggests that they will be found to be more suitable for the senior boys, than for beginners in the lower forms. For the former they ought undoubtedly to be useful, in spite of a certain want of suggestiveness, in the arrangement of the book, which seems likely to impair the educational value of the course, by leading the student to look upon the experiments as mere bits of manipulative and mental gymnastic, and to overlook their relation to the science as a whole. This is a defect, however, which may be remedied by the teacher, by means of verbal discussions of the results obtained, and by rearranging the order of the experiments to suit his methods of teaching.

Whether Mr. Highton's book will soon find a sufficient field of usefulness, we cannot say. We hope it may, but we fear it may not ; for, alas ! too many teachers are still very much at the mercy of the examiner, and qualitative analysis still rules supreme in many of the leading examinations at which public school boys compete. Doubtless it is very difficult to make fundamental changes in an examination syllabus, and it must be admitted that the Examining Boards would

provoke howls of disapproval if, in the year 1899, they should suddenly ordain the complete abolition of qualitative analysis. But it is a question whether the time has not now come for a forward movement in this matter.

We will conclude with a suggestion. Is there any reason why those who control "certificate examinations," "army examinations," "scholarship examinations," and the like, should not, on and after some reasonably early date, permit candidates in chemistry to choose between qualitative and quantitative practical work? Such an ordinance would herald a new era of progress in the chemistry teaching of our schools. Nor would the change be so difficult to carry out as might, at first sight, seem probable, for scholarship examiners at the Universities have long since shown us how to examine boys in quantitative analysis. Indeed, had they not unfortunately made the initial mistake of requiring a knowledge of quantitative work without definitely reducing the range of the qualitative previously required, the University Examiners would long since have solved the whole problem. Even as it is, some good has been done—for a start has been made. But in the interests of sound teaching it is vitally important that this mistake should not be repeated, and that those who are responsible for these matters should remember that the time which has been found to be insufficient to afford a sound training in qualitative analysis cannot possibly be sufficient for both qualitative and quantitative work, especially if inorganic preparations are also to be made by the students as they should be. W. A. S.

OUR BOOK SHELF.

The Illustrated Annual of Microscopy. Pp. 164. (London: Percy Lund, Humphries, and Co., Ltd., 1898.)

THE first number of this publication is a very creditable production, from whatever point of view it may be regarded. It is written primarily for the amateur, although some of the articles included could be read with interest by any microscopist, for they indicate the work that has been undertaken and carried out during the year. Perhaps, however, it is in this very direction that the book is deficient, as in some of the articles, instead of treating only those parts of the subject which are of recent interest, a large amount of matter is included that can be found in any good work on microscopy. It might safely be assumed that those who are sufficiently interested in the subject will have the necessary knowledge to enable them to understand the points under discussion without this preliminary instruction. This fault, if it may be called so, is perhaps almost inseparable from the first number of a work of this kind; but no doubt in future numbers there will be less difficulty in attaining the object the publishers state they have in view.

Of the papers calling for special mention, those on bacteriology are all deserving of notice, not the least interesting to the amateur being that by Rev. W. Spiers on "Amateur Bacteriology," in which various simple devices are described, enabling those who have no special apparatus to do a considerable amount of bacteriological work. This is all the more important, as it is thought by many that the study of bacteria is limited to those who have the resources of a bacteriological laboratory at their disposal, whereas there is a considerable field of work open to any one who has a microscope, without entailing any but the most modest expenditure. A paper on "The Diphtheria Group of Bacilli" deals with an important subject, and one to which considerable attention has been given of late. The paper on "Multiple Colour Illumination," by J. Rheinberg, describes a simple method of effectively exhibiting microscopic objects which, of themselves, do not possess any colour contrast. The microscope and its optical parts comes in for a good share of attention. There is an article on "The Microscope in 1897," by Dr. Henri van Heurch, the mention of whose name is sufficient guarantee of its interest. Mr. Edmund J. Spitta treats of "Achromatics *v.* Apochromatics," and endeavours to show, by a series of photo-micrographs, the immense superiority of the latter. Nearly all branches of microscopy have been touched upon, and into whatever channel the interest of the reader may be directed he is almost sure to find something of interest. Altogether, the book is admirably produced; the illustrations, which are nearly all reproductions from photographs, being of the highest class, and comparing favourably with any of the kind that have been published. It is to be hoped that the publishers will find it possible to continue the issue of this annual, as it cannot fail to be of interest and value to microscopists.

J. E. B.

Wild Animals in Captivity. By A. D. Bartlett; edited by E. Bartlett. Pp. viii + 373, illustrated. (London: Chapman and Hall, Ltd., 1898.)

THE late Mr. Bartlett had such an extensive and almost unrivalled practical acquaintanceship with animals in menageries, that the publication of the notes kept by him during a long life might naturally be expected to be an event of more than usual interest. But, although there is much to attract general attention, and not a little worthy the notice of the practical zoologist in the present volume, we cannot help rising from its perusal with a certain feeling of disappointment. It appears, indeed, that a very large proportion of the notes that have any real value have been published elsewhere. And although this is a matter of little or no moment when the subject is good and attractive, it is essential that such republished notes should be well arranged and edited. In our own opinion efficient editorship is sadly wanting in this instance. The various notes and papers are far from being well arranged; and there is a considerable amount of repetition, as well as much irrelevant "padding," which might advantageously have been omitted. As a glaring instance of the former fault, the reader may be referred to pp. 164 and 165, where he will find precisely the same anecdote, with identical dates, repeated under two distinct headings; the only difference being that one account is more detailed than the other.

The diction, too, in many places, if not actually unungrammatical, is decidedly inelegant; and the need of competent scientific editorship is strikingly apparent in the concluding chapter of the book, which treats of the food of animals in captivity, and is one of the most valuable in the whole volume. Misprints, also, are by no means absent; the substitution of the word "joints" for "points" rendering a sentence on p. 27 almost unintelligible.

Neither do we consider the preliminary biographical notice of a decidedly remarkable man all that it might be; and, while the rest of the volume might be much abbreviated with advantage, this part would well bear expansion.

With regard to the merits of the book, all readers will admire the many anecdotes of the striking personal courage and devotion displayed by the late author in his dealings with the animals under his charge. There is much, too, in regard to their general habits in confinement which cannot fail to be of importance to all

connected with menageries; while many of such notes are valuable clues to their mode of life in a state of nature.

A subject in which Mr. Bartlett took especial interest is that of hybrids; and to him, amongst others, belongs the credit of showing that sterility is by no means such a general attribute of the products of crossing as has been supposed. The chapter on hybridisation is, therefore, worthy of the best attention of naturalists.

R. L.

Wild Life at Home. How to Study and Photograph it. By R. Kearton, F.Z.S. Pp. xv + 188. (London: Cassell and Co., Ltd., 1898.)

THIS delightful book, by the author of the well-known "With Nature and a Camera," deserves a wide popularity. It should be of value in spreading the love of the "bloodless and harmless sport," of which Mr. Kearton writes so enthusiastically. The beautifully reproduced photographs are in themselves more than justification for the addition of the volume to the numerous bird-books already in existence, and the careful and practical instructions which are given to the reader, to enable him to secure similar trophies to those illustrated, will tempt many nature-lovers to follow in the footsteps of Mr. Kearton and his brother, Mr. C. Kearton, who has provided the photographs. In addition to illustrations and notes on birds, the volume contains chapters, with striking pictures, on mammals, insects, and other forms of life.

A Pocket Dictionary of Electrical Words, Terms and Phrases. By Edwin J. Houston, Ph.D. Pp. iv + 945. (London: Swan Sonnenschein and Co., 1898.)

THE growth of the terminology of electrical science has been so rapid, that the new terms and phrases coined since the publication of the last edition of the author's larger dictionary, exceed in number those which were originally in use. This necessitated a re-casting of the previous work; and to avoid the production of a cumbersome volume, the greatest attention has been paid to conciseness of expression, with the result that this handy little epitome has been produced. It is even now too large for a pocket dictionary, and it would perhaps have been better to have reduced the bulk by omitting many of the words which are familiar enough to need no explanation.

Ricettario Industriale. By I. Ghersi. Pp. 562. (Milan: Ulrico Hoepli, 1899.)

This book, which is one of the latest additions to the well-known series of "Manuali Hoepli," contains some 940 recipes used in the arts. Among these there are many which will be of value to scientific workers. Of the subjects treated, the following are a few of the more important: Coloration, plating and cleaning of metals; paper, celluloid, cements, ebonite, matches, preservation of fruit, flowers, eggs, &c.; bleaching, ink, oils, perfumes, soap, varnishes, ivory, glass, wine. So far as we are able to judge, the recipes given are practical and up to date.

Deutscher Botaniker-Kalender fur 1899. By P. Sydow. Pp. 198. (Berlin: Gebruder Borntraeger.)

THE dates of the births or deaths of distinguished botanists, mostly natives of Germany, are indicated in this pocket diary for 1899. In addition, the rules of nomenclature followed by officers in the Imperial botanical gardens and museums of Berlin are given; and there are lists of works on cryptogamic plants, of botanical gardens in Germany and elsewhere, botanical and natural history museums and collections, and an alphabetical list of the officers in botanical museums and great herbariums.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Anthropological Expedition to Torres Straits.

THE members of the Cambridge Anthropological Expedition to Torres Straits have now completed their investigations in the Straits. Dr. Rivers and Mr. Wilkin have left for England, while the other members of the expedition have proceeded to Borneo to study the anthropology of the Baram district of Sarawak. The health of the party has been excellent.

The natives of Murray Island were studied with most detail, as, owing to their isolation, they have been less modified by contact with alien races. Some of the party stayed about four months on the island, while others had only a couple of months, owing to a trip having been made to the mainland of New Guinea.

The New Guinea contingent visited the coast tribes between Kerepunu and the Mekeo district, and several excursions were made for short distances inland. There was not enough time spent at any spot for a thorough investigation of the natives, but a considerable amount of information was obtained in most of the branches of anthropology with which the expedition is concerned, which will prove of value for purposes of comparison.

The researches on the Murray islanders were fairly thorough, and will form a basis for comparison with the other islanders and allied peoples. Over a month was spent in Mabuiag (Jervis Island) by all the party, with the exception of Messrs. Myers and MacDougall, who had previously started for Borneo. Although the time spent in Mabuiag was short, a satisfactory amount of work was accomplished owing to the conditions being favourable. Observations were also made on several other islands in Torres Straits and in Kiwai, which is situated in the mouth of the Fly River.

A large number of photographs have been taken, and considerable collections have been made, which are now on their way to Cambridge.

A. C. HADDON.

Thursday Island, November 7.

Transference of Heat in Cooled Metals.

SEVERAL observers[1] have noticed a rise of temperature at the cooler end of a bar of metal when the hot end was suddenly cooled. As this would be a most surprising effect, and as Johns Hopkins University has been mentioned in connection with the subject, Dr. H. A. Rowland has requested me to examine the matter.

Iron and steel bars of about one-half inch diameter were used, and iron-copper thermo-electric couples were soldered to the cooler end and the side. A reflecting galvanometer was used that gave a deflection of 1 mm. per 0°·05 C. The end of the bar was heated by a Bunsen compound burner, or in a muffle furnace with a blast lamp. The hot end of the bar was cooled either with blocks of ice or by plunging into ice water.

After errors, due to jarring the galvanometer, and to changes in the magnetic field of the galvanometer, caused by motion of the bar, had been eliminated, even under the most trying conditions no effect was observed. The temperature of the cooler portion of the bar did not increase when the hot end was suddenly quenched.

The most severe test imposed included the sudden quenching in ice water of the end of the bar, three inches of which was above the red heat. The thermo-couple then was only nine inches from the glowing end of the bar.

The galvanometer, of course, showed the usual slow change of temperature due to conduction. There was then a comparatively long time after quenching before any change of temperature was indicated, and then the change was only a reduction of temperature.

CARL KINSLEY.

Johns Hopkins University Physical Laboratory,
Baltimore, U.S.A., December 9.

[1] NATURE June [illegible], 1898 (observed by M. Bourget in Paris [illegible]); September 1, 1898 (observed by Mr. Bartlett in Cavendish Laboratory, 1899); October [illegible], [illegible] (observed by Mr. Stone in Johns Hopkins Laboratory, 18[illegible]).

Where do we stand in Brückner's Weather-cycle?

THE problem of future weather is one which has a fascination for many. Our present inability to get beyond (or much beyond) the daily forecast, may well, at times, seem a reproach, considering the immense amount of industry that has been given to weather studies. Where is the professional meteorologist in this country (we vainly ask), who, on the basis of some cycle, or proved recurrence, or other facts, will tell us, even in the most general way, what the coming years have in store for us?

Yet the time may not be so very distant, I think, when science will be able to say, *Nous avons changé tout cela.* The evidence of cycles is growing; and their character is being more exactly fixed. An attentive reader of that excellent record, the *Meteorologische Zeitschrift*, may observe, now and again, a feeler (so to speak) put forth into the obscure; a serious attempt to extend the range of prevision, a suggestion, by some well equipped mind, as to the course of weather in coming years or seasons. Have we not in such the hopeful beginnings (hopeful even in case of failure) of a new and difficult art?

There are two weather-cycles, which have lately been (shall I say?) knocking for admittance; that of 11 years, and that of 35 years. It is well to bear in mind that these are not mutually exclusive. They may be found to usefully supplement and help each other.

Brückner's views as to the recurrence, at intervals of about 35 years, of cold and wet periods, alternating with warm and dry ones, seem to have hardly received, as yet, in this country, the attention which they deserve. They are destined, I believe, to have a large influence on future thought about such matters. It may be useful to ask how our London weather is related to this 35 years' cycle; and I propose to do so here from the standpoint of barometric pressure.

The method adopted is this: Each month, in a long series of years (from 1786), is first characterised as + or −, according as its pressure has been above or below the average. (Tables by Eaton and Glaisher have been used for the purpose.) Then the plus months in each year are counted, and the series of numbers so obtained is smoothed by additions of 10 (*i.e.* adding the first 10, then from the 2nd to the 11th, the 3rd to the 12th, and so on, each sum being put down in the *fifth* place). This gives us the dotted curve A in the diagram, in which may be seen, underlying minor variations, a succession of long waves. The general outline of these waves may be more clearly brought out by a further smoothing process (continuous curve).[1]

In order to clear understanding of this curve A, consider, for a moment, its lowest point, that for 1842; this means, that, in the 10 years, 1838–47, there were 50 months of + barometric pressure, out of 120. Similarly, the highest point (that for 1891), means that in the 10 years 1887–96, there were 67 months of + pressure out of 120.

Note the intervals between minima of this curve A. From 1813 to 1842, 29 years; 1842 to 1876 (34 years). Or, taking the twice-smoothed curve, we get 35 and 32 years. On the other hand, the two completed waves are approximately bisected by the vertical lines for 1830 and 1860 (interval 30 years).

At the top of the diagram are two linear series representing, the one, Brückner's warm and cold, the other, his dry and wet, periods (warm and dry, continuous lines, cold and wet, dotted lines). These two series, for temperature and rainfall, are not, it will be seen, exactly coterminous; the latter tend to lag somewhat on the former. Brückner's general figures may be given, so far as they here concern us.[2]

Temperature.		Rainfall.	
Warm ...	1791–1805 (15 yrs.)	Dry ...	1781–1805 (25 yrs.)
Cold ...	1806–1820 (15 „)	Wet ...	1806–1825 (20 „)
Warm ...	1821–1835 (15 „)	Dry ...	1826–1840 (15 „)
Cold ...	1836–1850 (15 „)	Wet ...	1841–1855 (15 „)
Warm ...	1851–1870 (20 „)	Dry ...	1856–1870 (15 „)
Cold ...	1871–1885 (15 „)	Wet ..	1871–1885 (15 „)

Now, it will be noticed that our barometer curve A at its lowest points is generally about the middle of the cold periods, while the middle of the waves is about the middle of the warm periods. Also, that the parts of the twice-smoothed curve above the average line are about coterminous with warm periods; while the parts below the average line are in general coterminous with cold periods.

[1] Here the sum of 10 items is put down in the *sixth* place.

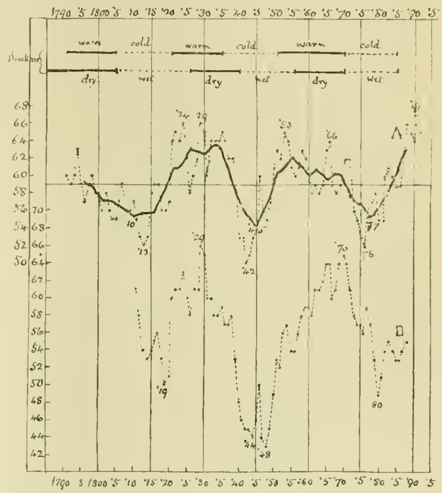
[2] *Klimaschwankungen*, p. 236.

It is surprising, I think, that an agreement so considerable can be brought out by a method so rough.

Do not these facts throw some light on the future? An interval of 35 years from the last minimum, 1876, brings us to 1911, about which time (perhaps a little earlier) we might fairly look for another minimum, the middle of another cold and wet period. At present we are still, apparently, in the warm and dry period commencing about 1886, and probably near the end of it, as (say) 15 years from 1885 brings us to the end of the century. We next enter (by programme!) on another time of cold and wet, with preponderance of low barometers. Thus our curve A should be turning down soon towards its next minimum (situated somewhere between 1906 and 1911).

The rainfall aspect of the current warm and dry period may be put thus: Of the fifteen years, 1883–97, twelve have been dry, and only three wet. 1882 seems to mark the end of a long time of preponderance of wet years.

The curve B is one for Paris, made out in the same way as A (the data, however, extending only to 1893). It shows much the same kind of fluctuation. One curious feature is a lag in the three minima behind those of the London curve.



Regarding barometric pressure in these regions, Brückner considers that in a dry period there is a deepening of the usual cyclone in the North Atlantic (on an annual average), and an intensifying of the ridge of high pressure reaching from the Azores to the interior of Russia, especially in Central Europe; also a general increase of amplitude in the yearly variation (*Klimaschw.*, p. 217). In wet periods, the pressure differences (both from place to place and from season to season) are lessened.

There can be little doubt that this cycle of Brückner's touches life at many points, and that a promising field of study is thus opened up. Take health for example. Brückner himself shows how the mortality from typhus at Bâle has varied with the cycle (being worst in the dry periods). In a recent valuable work on epidemic diphtheria, Dr. Newsholme correlates the mortality from that disease in England with the thirty-five years' cycle, showing that a succession of dry years afford the most favourable conditions for growth of the disease.

ALEX. B. MACDOWALL.

Soakage into Glazed Porcelain.

I MIX salt with water for occasional gargling, and keep it in a porcelain pot with a lid. Some weeks ago I began to use for the purpose a small well-glazed pot, in which cold cream had been bought a long time since. It was thoroughly washed by a

careful servant, and the salt put into it. However, after a few weeks the salt became so strongly impregnated with the odour of rancid grease that it was not fit to be used, and I threw it away. The pot was washed a second time with scrupulous care: it seemed to me quite pure and free from odour: a new supply of salt was put into it, and now for the second time the salt has began to smell intolerably rancid. The interest of this is two-fold. First, it shows how large an amount of impurity is able to penetrate glazed porcelain, as photographers know to their cost; and secondly, it proves the possibility of concentrating odour. An imperceptible discharge from the porcelain was accumulated and stored in the salt until, when the lid was removed, it was found to be overpoweringly strong. The scent may therefore be said to have been *magnified* by these means, as much as a sound is magnified by an ear-trumpet, or a visible object by a lens. F. G.

The Twelfth Movement of the Earth.

UNDER the above heading a short article appears in the *Bulletin de la Soc. Astronom. de France*, October 1898, p. 449, which on account of its interest and of its brevity, as well as its geological significance, is well worth citation, although the matter of it has already been brought before the public by other *Journals* and *Proceedings* of learned bodies.

"The planet which we inhabit has been known by astronomers to be subject to eleven different movements.

(1) Its diurnal rotation around its axis in 23h. 56m.

(2) Its annual revolution round the sun in 356¼ days.

(3) The precession of the equinoxes in 25·765 years.

(4) The monthly movement of the earth about the centre of gravity of the earth-moon couple.

(5) The nutation caused by the attraction of the moon in 18½ years.

(6) The secular variation of the obliquity of the ecliptic.

(7) The secular variation of the eccentricity of the terrestrial orbit.

(8) The displacement of the line of apsides in 21·000 years.

(9) The perturbations caused by the constantly changing attractions of the planets.

(10) The displacement of the centre of gravity of the solar system round which the earth annually turns, which centre depends on the variable position of the planets.

(11) The general translation of the solar system in the direction of the constellation Hercules.

A twelfth movement, that of the terrestrial pole to the extent of 15m. to 17m. per year, which gives rise to a slight variation of latitudes for all countries, is at present the object of assiduous verifications in a certain number of observatories.

Mr. Albrecht has traced out the path followed by the pole about its mean position from month to month, according to the observations of latitude made since January 1, 1890, to June 1, 1897. This slight displacement is due more especially (surtout) to a variation of equilibrium produced by the movements of the atmosphere of the ocean."

It appears singular that this movement of the pole (and consequent variation of latitude) thus clearly determined to be taking place, has not led to any appreciations as to its possible and probable significance in geology. Amongst the many causes advanced to account for the derangements of land and ocean, and consequent changes of climate at various geological periods, has been a supposed displacement of the axis of the earth, which astronomers have been unwilling to admit as having taken place to any notable extent, and which up to the present it was not possible to prove as having really ever existed. Sir Arch. Geikie, in his "Text-book of Geology" (1885), p. 15, discusses the question sufficiently fully, and arrives at the conclusion (p. 17): "Under the most favourable conditions, therefore, the possible amount of deviation of the pole from its first position would appear to have been too small to have seriously influenced the climates of the globe within geological history."

Secular contraction is admitted as a consequence of the slow cooling of the earth, but the rate at which it acts, or its estimation as a force, is hardly attainable. That it may be, and is frequently a cause of earthquake action is admitted. Hence, considering it as a force acting at all parts of the earth's surface with greater or less energy, it is presumable that it is maximum in certain places, and may be so at points in the vicinity of the equator. Its energy may, indeed, here in places, have reached the point, from time to time, of balancing the centrifugal force proper to these places; and in this case it is evident that the ground in such places might be considered as being in unstable equilibrium, and liable to elevation or depression on the occurrence of very slight differences between the two forces in question arising from one cause or another. Now, under such conditions of equilibrium, it is just possible that a very slight variation of intensity of the centrifugal force at the place considered, could give rise to a derangement of the earth's surface such as would be attributed to an earthquake. This variation in the intensity of the centrifugal force might be the result of the movement of the polar axis, and possibly of a very slight movement such as recently observed. But if it be admitted that this movement is continuous, and if it be supposed that it may have been much more intense and much more frequent in former times, it is evident that it may have been a potent agent in bringing about alterations in the relative distribution of land and water in the zone of the equator, and it is reasonable to examine the actual state of this zone for some evidence of such former movements of the polar axis. Now, the equatorial zone lying between 10° to 15° north and south of the equator, is markedly characterised by the predominance of the ocean surface. The equatorial line only traversing land in Africa and South America, Borneo and Sumatra over a total length of about 90°, the remaining 276° of its extent lying on the Pacific, Atlantic and Indian Oceans. The localities where it traverses the land surface are remarkable in respect to their level as regards the sea. Thus the African part of the belt covers a large extent of the watershed valley of the Congo River, and the Victoria Nyanza basin. In a quite recent article in the *Scientific American Supplement* (Sept. 24, 1898, p 19008), the basin of the Congo "has (it is said) been compared by geologists to the dried up bed of an interior sea." In South America the southern portion of the zone represents the watershed valley of the Amazon, that is, a low-lying tract of land. The course of the zone where it traverses the Indian Ocean and the islands of Borneo, Sumatra, and Celebes, is over one of the most disturbed portions of the earth's surface, that is, where alterations of level, with accompanying seismic and volcanic phenomena, have been frequent and almost continuous. Furthermore, one of the results of a change in the position of the polar axis and variations of the intensities of the centrifugal force on the equatorial zone would be, that for points diametrically opposed, the decrease of centrifugal force at one point would necessarily imply an increase of the force at the opposite point, so that if subsidence took place in the one, elevation should be the result in the other, so that wherever the equator traverses land (representing elevation) it should be found traversing ocean (or low land) at the opposite end of the diameter corresponding to this elevated land surface. This practically holds good, since to the African belt is antipodal, a certain extent of the Pacific, while to the South American belt corresponds diametrically the portion of the Indian Ocean occupied by the islands of Sumatra, Borneo and the Celebes, so markedly characterised by the evidences of former and present seismic and volcanic actions. There is, therefore, some probability that in the present arrangement of land and water in the equatorial zone, there may be the traces of former changes of the polar axis. It is well to bear in mind, as regards these small movements of the axis frequently recurring, if not continuously, and giving rise consequently to small but repeated changes in the relative intensities of secular contraction and centrifugal force, that they may really be most potent agents of change, and that therefore, however small, they acquire great significance if found to be recurrent and tending to repeat themselves at more or less regular intervals, and intervals much shorter than those usually assigned to geological phenomena. J. P. O'REILLY.

The Geminid Meteors

WILL you allow me to supplement the observations of the Geminids recorded in the first paragraph of your "Astronomical Column" in NATURE of December 19, p. 157, by mentioning some of my own? They may be interesting as showing the continuance of the shower, as I was unable to begin to keep watch until 12h. 30m. on the 12th. Twenty-seven meteors which appeared in the south and south-east were charted between that hour and 14h. 45m., when clouds finally covered that part of the sky. Of these, sixteen were from one or other of three radiants in Gemini, the most brilliant occurring at 12h. 42m. (= 1st magnitude), at 13h. 35m. (= magnitude 1½), at 14h. 16m. (= 1st magnitude), and at 14h. 23½m. (= Jupiter in bright-

ness). It will be seen, therefore, that with regard to frequency of meteors this later portion of the shower was not to be compared with that witnessed before midnight. Twelve meteors, including one of the first magnitude and two even brighter, were mapped between 11h. 30m. and 13h. on the night of the 9th; four of these were Geminids.

W. E. BESLEY.

70 Vincent Square, S.W., December 16.

Slug following a Closed Trail.

MY attention was drawn a few days ago to a brown slug, about 2½ inches long, which had made for itself a closed iridescent track on the concrete flooring of a conservatory. I could not find at what point it had got on to the curve, which ran at one end into a damp part of the concrete, but, in four hours from the time I first saw the slug, it had made three complete circuits and two-thirds of a fourth, always keeping the whole of its body on the trail. The latter, of a uniform breadth of 3/16 inch, varied considerably in curvature, but nowhere presented any very sharp corners, and measured, roughly, forty inches round. Though the rate of progression was sufficiently slow, the slug rested on the track for seven hours, after which, thinking it dead, I touched it and found it had not quite dried up. Indeed, without elongating its body, it began to move and laboriously shifted its position by about an inch. There it remained (the time being then 10 p.m.), waiting, perhaps, for the influence of a more humid atmosphere, for morning found it moist and healthy, breakfasting more than a yard from the near and damp end of the track, which it must have reached by completing the fourth circuit, as there was no trail other than the closed one alluded to. If slugs are in the habit of following old trails, it does not appear that the present specimen had any previous experience of a re-entrant path, but that it depended solely on ocular intelligence of the path in advance.

VINCENT DANIEL.

151 Crwys Road, Cardiff, December 13.

Animals Feeding on Poisonous Plants as Food.

APROPOS of the various instances quoted of animals feeding on poisonous plants, it may be of interest to mention that in this part of India (the North-west Provinces), goats frequently eat, without any ill effect, the leaves and green stems of the "Akaúa" or "Madar" (*Asclepias* or *Calotropis gigantea*), the milky juice of which is an acrid poison for human beings, and is frequently used as such in infanticide cases.

CHAS. A. SILBERRAD.

Muttra, India, November 18.

THE FUMIGATION OF TREES.[1]

THE San José Scale was first discovered by Prof. J. H. Comstock, near San José, California, in 1879, and was named by him *Aspidiotus perniciosus.* It has been found in various parts of the world, and its original habitat has not yet been ascertained with certainty, but is conjectured to be Japan. In 1893 it was first discovered in the Eastern States, having been introduced about six years before with some infested plum-trees from California, in the attempt to obtain an improved plum which should be proof against the attacks of the plum-weevil; but this laudable object proved the means of introducing a much worse pest into the Eastern States. According to the pamphlet before us, it has now been introduced into no less than thirty-three States, besides Canada and British Columbia, chiefly from the centre of infection in New Jersey. The State of Maryland is badly infested, large orchards of plum, pear, peach, cherry, &c., having been almost entirely destroyed by it in some localities. The insect attacks trees and plants in a similar manner to other *Coccidae*, attacking a great variety of plants, and spreading over leaves, trunk, branches, and fruit indiscriminately. The effects of various remedies are discussed by Prof. Johnson, spraying with whale-oil soap, and fumigating with hydrocyanic acid gas, appearing to be the most satisfactory and efficacious remedies.

FIG. 1.—Placing a tent in position over a plum-tree.

[1] "Report on the San José Scale in Maryland, and Remedies for its Suppression and Control." By W. G. Johnson, A.M., Entomologist. (*Bulletin* No. 57 of the Maryland Agricultural Experiment Station, College Park, MD., August 1898.)

The accompanying illustrations, selected from those in the Report, illustrate the mode of applying the latter remedy.

We may add that other countries have become alarmed at the ravages of the San José Scale in America; and in Germany, in particular, it is not only absolutely forbidden to import any living plants of any kind from America, but even from any other country, without a satisfactory declaration that they are not of American origin.

W. F. K.

FIG. 2.—Experimenting with hydrocyanic gas in a block of 2500 Bartlett pear-trees infested with San José Scale.

CURIOSITIES OF ORCHID BREEDING.

A FEW years ago the raising of hybrid orchids was entirely in the hands of a few English experts, but quite recently it has been taken up with great success by many growers of these rare and beautiful plants, not only in England, but also on the continent and in America.

Consequently orchid hybrids have become very numerous, while new ones are constantly being brought to light. Up to the year 1860, we find but four flowered hybrids recorded, raised from distinct crosses: during the thirty years following the numbers gradually increased, until in 1890 there were about 200 enumerated. But it is in the present decade that the most rapid strides have been made, the numbers having increased by leaps and bounds until at the present time there are on record no less than 800 orchid hybrids, raised by hand from distinct crosses. These have all flowered in gardens, and have been duly described or recorded in various journals. And when we remember that many of these 800 crosses have been repeated in the same garden, and in other gardens, and that many individual plants may have been obtained from each capsule, we can form an idea of the large numbers of hybrid orchids that have been raised by hand.

Primary Hybrids.

Of the 800 hybrids from distinct crosses, now on record, some 500 are primary hybrids, *i.e.* hybrids of the first generation between two different species. A careful examination of these primary hybrids shows that, as a rule, they are fairly intermediate between their parents, partaking of the characters of both, and at the same time perfectly distinct from either. The latter fact is most remarkable, and at once serves to distinguish primary hybrids clearly from all other hybrids. For example, *Cypripedium* × *Leeanum* is a typical primary hybrid, and has perhaps been raised more frequently and in larger numbers than any other orchid hybrid. It was obtained originally by crossing *C. insigne* (Wallich), ♀, with *C. Spicerianum* (Rchb. f.), ♂, both well marked and distinct species. The hybrid is fairly intermediate both in its outward characters and in its inner structure (see Prof. Macfarlane on "Minute Structure of Plant Hybrids," *Trans. Roy. Soc. Edin.*, 1891, xxvii. p. 245), and although it has innumerable minor and individual varieties, yet it is always perfectly distinct from both of its parents.

Nor has any intrinsic difference been observed in the reciprocal cross, the same forms appearing equally in the obverse and reverse crosses. Often many varieties are obtained from the same capsule, differing slightly in colour, form and size, but all are specifically *C.* × *Leeanum*, and cannot be mistaken for anything else. As it is with *C.* × *Leeanum* so it is with other primary orchid hybrids, so far as experiments have been made. In short, we find that primary hybrids are, as a rule, so intermediate between their parent species, and so com-

paratively uniform in character, that they are specifically distinct from both parents.

Generic Hybrids.

Of the 500 primary hybrids on record, about 100 are generic hybrids, *i.e.* the parents belonging to different genera. In this respect alone these hybrids are interesting, though no doubt the systematic botanist views them with mixed feelings. It is not so long since generic hybrids were looked upon as anomalies, some of the older naturalists even regarding them as impossible, and forthwith proceeded to beg the whole question by classing those genera which were fertile with one another as species of one. Orchid growers, at all events, have almost ceased to regard generic hybrids with curiosity, familiarity with them having bred a certain amount of indifference.

A list of the generic hybrids on record up to the end of 1897, together with a diagram showing how twenty-six different genera have been linked together by artificial hybridisation, has been prepared by the writer and was published in the *Journal* of the Royal Horticultural Society (vol. xxi., April 1898), and to which those interested in the details of generic orchid hybrids may be referred.

Generally speaking, primary generic hybrids follow the rule of specific hybrids in bearing the intermediate characters of their parents, with a narrow range of variation.

But there are a few remarkable exceptions to this rule.

(1) *Epiphronitis* × *Veitchii*, a hybrid out of *Sophronitis grandiflora* (Lindl.) by *Epidendrum radicans* (Pav.).

(2) *Epi-Cattleya* × *matutina*, a hybrid out of *Cattleya Bowringiana* (Veitch) by *Epidendrum radicans* (Pav.)

(3) *Epi-Laelia* × *radico-purpurata*, a hybrid out of *Laelia purpurata* (Lindl.) by *Epidendrum radicans* (Pav.).

(4) *Epi-Laelia* × *Charlesworthii*, a hybrid out of *Laelia cinnabarina* (Lindl.) by *Epidendrum radicans* (Pav.).

These four generic hybrids are very curious indeed, inasmuch as all agree in reproducing the generic characters only of the pollen parent Epidendrum, without the slightest trace of the peculiar structure of the seed-parents, Sophronitis, Cattleya and Laelia. Yet in minor characters, in colour, form and size, the four hybrids distinctly differ from one another and from their Epidendrum parent.

A close examination reveals the fact that these minor differences correspond with the peculiar differences in the parentage, thus showing that the crosses have really been effected: yet at the same time it must be candidly admitted that did we not know the parentage, we could never have determined it, so overwhelming is the influence of the predominant partner *Epidendrum radicans*. It will, no doubt, be observed that *E. radicans* is the pollen parent in each of the above cases. Curiously enough, when this reed-like *E. radicans* is crossed with the pseudo-bulbous *E. vitellinum* (Lindl.), ♀, a similar result is obtained, the offspring *E.* × *radico-vitellinum* being scarcely distinguishable from the reed-like *E. radicans*. Again, when the reed-like *E.* × *O'Brienianum* —itself a hybrid out of *E. evectum* (Hook. f.) by *E. radicans*—is crossed with the pseudo-bulbous *E. vitellinum*, ♀, a similar result is obtained, the offspring being reed-like in habit as in the pollen parent. Yet when the reed-like *E. radicans* is crossed with other reed-like species of Epidendrum. and again when the pseudo-bulbous species of Epidendrum are crossed with species of Laelia, in every case normal hybrids are produced intermediate between their parents.

Though we cannot pretend to unravel this tangled skein, yet, so far as experiments have been made, it seems quite clear that (1) the species of Cattleya, Laelia, Sophronitis, and the pseudo-bulbous species of Epidendrum, when intercrossed, produce normal hybrids intermediate in character.

(2) The same result is obtained when the reed-like species of Epidendrum are united with one another.

(3) But when the reed-like species of Epidendrum are united with the pseudo-bulbous species of Epidendrum, or with species of Cattleya, Laelia and Sophronitis, abnormal hybrids are produced, having the essential characters of the reed-like Epidendra. From these facts it might easily be argued that a reed-like Epidendrum was the ancestor not only of the pseudo-bulbous Epidendra, but also of the more highly specialised genera Cattleya, Laelia and Sophronitis. In that case the pseudo-bulbous Epidendra would form an interesting connecting link between the lowly reed-like Epidendra and the gorgeous aristocratic Cattleya and Laelia.

Prepotent Generic Crosses.

Perhaps the strangest curiosity in the history of orchid hybridisation is the remarkable prepotency of the genus Zygopetalum over the three genera Odontoglossum, Oncidium and Lycaste, so far as experiments have been made. *Zygopetalum Mackayi* (Hooker) has been crossed with four distinct species of Odontoglossum, viz. *O. Pescatorei* (Linden), *O. crispum* (Lindl.), *O. grande* (Lindl.) and *O. bictonense* (Lindl.), also with one species of Oncidium, *O. unguiculatum*, and one species of Lycaste, *L. Skinneri* (Lindl.), by more than one hybridist, and the result has always been the same, namely *Zygopetalum Mackayi* pure and simple, without a trace of the peculiar structure of the pollen parent in any case. This result is very perplexing and exceedingly difficult to account for. I have made careful inquiries into the details of all these cases, and have satisfied myself that accidental self-fertilisation is out of the question, the pollen of the mother parent having been carefully removed in every case previous to pollination. Parthenogenesis, too, is evidently a broken reed to lean upon, for the seedlings from the same seed-pod differed among themselves in colour and other minor characters, which would hardly have been the case had they arisen from parthenogenetic seed-buds. Neither is *Z. Mackayi* naturally prepotent over other species when crossed, there being at least three cases to the contrary. Nor is the genus Zygopetalum naturally prepotent over other genera, as two distinct and intermediate hybrids between Zygopetalum and Colax testify. As in the case of the Epidendrum crosses, mentioned above, it may be suggested that Zygopetalum is the ancestral genus of Odontoglossum, Oncidium and Lycaste, and that the characters of the ancestral genus remain latent in the more recent genera, with the result that when the latter are crossed with the former, the mixing of the germ-plasms causes these original characters to dominate, the outcome being a reversion to the ancestral genus Zygopetalum.

A rather interesting fact has come to light which certainly lends colour to the above speculation:—The seedling Odontoglossums, raised in the gardens of Baron Rothschild, of Paris, during the first eighteen months of their growth, are said to have resembled Zygopetalum more than they did Odontoglossum. This coincides with the established fact that living beings tend to resemble their ancestors in the early stages of their development. However, for the present we must suspend our judgment, and wait patiently for further facts: it is to be hoped that future experiments will throw more light upon these curious generic crosses.

Another curious fact in connection with generic crosses may perhaps be of interest, and that is the remarkable crosses between the East Indian species of Cypripedium and the South American species; these two sections of the old genus Cypripedium have recently been raised to generic rank, under the names of Paphiopedium and Phragmipedium respectively, by Mr. R. A. Rolfe, of Kew,

and seem to form two distinct and natural groups. Hybrids between these two new genera are peculiarly interesting, inasmuch as the former has a one-celled ovary, while the latter has a three-celled one, showing that this condition is no barrier to fertilisation. More than twelve distinct crosses between different species of these two genera are on record, and many plants have been raised, but so far all resolutely refuse to flower, notwithstanding the many inducements that have been put in their way, and many of them are now large vigorous plants, long past the usual flowering age. One plant of these crosses is recorded to have flowered in the United States, but as it flowered exactly the same as the mother plant in genus, species and variety, one cannot be quite sure that the cross was really effected.

Many of the remaining plants (the writer has several in his collection) are distinctly intermediate in their foliage and habit of growth, and clearly bear the stamp of their recorded origin.

Secondary and Tertiary Hybrids.

Of the 800 distinct crosses mentioned in the foregoing, some 270 are secondary hybrids, *i.e.* hybrids of the second generation, one or both parents being a primary hybrid; while thirty are tertiary hybrids, *i.e.* hybrids of the third generation, one of the parents, at least, being a secondary hybrid. So far no hybrid orchids are recorded to have flowered beyond the third generation, but perhaps it may not be premature to mention that unflowered hybrids of the fourth generation are known to be in existence. The writer has in his collection six hybrids of the fourth generation, five years old, all raised from the same capsule, and which contain in their pedigree five distinct species and three distinct hybrids. So that in the near future there will be ample material in this direction at the disposal of the student of heredity; with this distinct advantage, that orchids being individually valuable, their pedigree is carefully and systematically recorded, which unfortunately is more than one can say of the great majority of garden hybrids.

A careful examination of secondary hybrids, shows them to be very different from primary hybrids in their range of variation. As we have already seen, primary hybrids are comparatively uniform in their characters; so much so that, as a rule, they are quite distinct from their parents. On the other hand, secondary hybrids have a much wider range of variation, often approaching either parent, and sometimes even reverting wholly to one or the other. For instance, to take the simplest form of a secondary hybrid, *i.e.* a hybrid crossed with one of its parent species. We find that the offspring, as a rule, are very variable, a few reverting to the parent species and a few to the parent hybrid; but the great majority are intermediate forms approaching either parent, the whole forming a series of links between one parent and the other. In short, we find that secondary hybrids have a far wider range of variation than have primary hybrids.

Natural Hybrids.

The existence of natural hybrids was formerly thought by some naturalists to be highly improbable, if not actually impossible. But now, when absolute facsimiles of supposed natural hybrids have been raised by hand in gardens, from the same two species among which they naturally grow, they can no longer be regarded as pious speculations, but are indeed accomplished facts. The number of proved natural hybrids in orchids alone is now very considerable, with the result that many intermediate and doubtful forms, hitherto classed as distinct species, are now placed in their proper position as natural hybrids. Mr. R. A. Rolfe, of Kew, has done yeoman service in reducing the chaos of natural hybrid orchids to something like order. And so it has come to pass that artificial hybridisation, which it was supposed would lead systematic botany into the direst confusion, by the irony of fate, seems destined to be the only trustworthy means of saving systematic botany from its own confusion; and the systematist, however orthodox he may be, can no longer afford to ignore artificial hybrids.

Fertility of Hybrids.

The question of the fertility of hybrids is a highly interesting one, and especially important to the student of evolution; and I venture to think that recent experiments in orchid hybridisation have added considerably to our knowledge of the subject.

One of the principal objections to Darwin's theory of the origin of species was the supposed general sterility of hybrids.

Darwin fully appreciated this difficulty, and, after a careful and most elaborate survey of the whole question of hybridism, came to the following conclusions:—"First crosses between forms sufficiently distinct to be ranked as species, and their hybrids are very generally, but not universally sterile. . . . The sterility is of all degrees" ("Origin of Species," 6th ed., p. 262). Again:—"The sterility of distinct species, when first united, and that of their hybrid offspring, graduates by an almost infinite number of steps from zero (when the ovule is never impregnated, and a seed capsule is never formed) up to complete fertility. . . . This high degree of fertility is, however, rare ("Animals and Plants," 2nd ed., vol. ii. p. 163). Some fifteen years later, Dr. Alfred Russel Wallace took up a somewhat similar but more definite position. He writes:—"One of the greatest, perhaps we may say the greatest, of all the difficulties in the way of accepting the theory of natural selection as a complete explanation of the origin of species, has been the remarkable difference between varieties and species in respect of fertility when crossed. Generally speaking, it may be said that the varieties of any one species, however different they may be in external appearance, are perfectly fertile when crossed, and their mongrel offspring are equally fertile when bred among themselves; while distinct species, on the other hand, however closely they may resemble each other externally, are usually infertile when crossed, and their hybrid offspring absolutely sterile" ("Darwinism," 1890, p. 152). Since that time, hundreds of hybrid orchids have been raised in gardens; as we have already seen, there are now on record some 500 distinct primary hybrids raised from distinct species, also some 300 secondary and tertiary hybrids from distinct crosses, raised from parents themselves hybrids.

In the face of these facts, therefore, we can hardly maintain that "distinct species . . . are usually infertile when crossed," and still less can we assert that "their hybrid offspring are absolutely sterile." As it is with orchids, so it is with other garden plants that have been hybridised, *e.g.* roses, rhododendrons, dahlias, chrysanthemums, carnations, begonias, pansies, &c.: the wonderful forms seen in gardens at the present day are all hybrids of many generations, being the known product of more than one species; and these are all fertile in the production of seeds. Darwin seemed to attach much importance to the different degrees of fertility in hybrids ranging from complete fertility down to absolute sterility. At present we have no means of ascertaining the relative fertility of hybrid orchids with that of ordinary species, owing partly to the fact that very few crosses have been made in gardens between varieties of the same species, and partly to the fact that many thousands of seeds are contained in one capsule, being practically innumerable. But through the kindness of Mr. Reginald Young, of Liverpool (an enthusiastic connoisseur in Cypripediums) the writer has been able to work out certain statistics

bearing on the question of the comparative fertility of hybrids (see *Journ. Roy. Hort. Soc.*, vol. xxi., April 1898).

The voluminous records in Mr. Young's stud-book cover a period of about five years, and were specially selected by the writer on account of the reputation of the breeder as a careful observer and a precise recorder. Out of the 577 crosses made by Mr. Young among thirty distinct species and fifty-three distinct hybrids of the new genus Paphiopedium, no less than 78·3 per cent. proved fertile, *i.e.* produced good seeds.

Of these, the crosses between distinct species only, 95·2 per cent. were fertile, while of the crosses in which a hybrid was concerned in the parentage 71·8 per cent. proved fertile.

This seems to show that crosses between distinct species are almost if not quite as fertile as crosses between varieties of the same species (taking the latter at complete fertility, *i.e.* 100 per cent.); while crosses with hybrids, though fertile to a high degree, are yet rather less fertile than crosses between species. A further analysis of the figures shows that while hybrids crossed with pollen of pure species give 89·5 per cent. fertile, yet pure species crossed with pollen of hybrids give but 56·7 per cent. fertile. This points to the conclusion that the slight decline in the fertility of hybrids is due in a large measure to the loss of power in the pollen of hybrids.

Why the male element in hybrids should be so much less potent than the female element I cannot pretend to say, but I venture to think that the matter is worthy of consideration as a possible factor in the evolution of species.

Evolution of Species by Natural Hybridisation.

The experimental demonstration of natural hybrids shows clearly that intercrossing between different species is carried on in a state of nature, to a far greater extent than was formerly supposed; and the comparative fertility of these natural hybrids would be of vital importance to them in their struggle for life.

If, as seems highly probable from the above experiments with orchids, it is the pollen only of hybrids that is impaired, and the capacity of the hybrid to bear seed crossed with the pollen of pure species remains practically unimpaired, it is quite clear that the natural hybrid has a part to play in the evolution of new species.

As we have already seen, hybridisation tends to increase variation especially beyond the first generation, and, naturally, the more variable the offspring the better fitted would they be to adapt themselves to changed conditions of life.

If the circumstances changed rapidly and considerably, the variable offspring of the hybrids would stand a better chance in the struggle for life than the more uniform offspring of the parent species, which were themselves specially adapted to the old conditions. In this way, as conditions changed, new species would be evolved more fitted to the new conditions of life than the old species, which they would gradually replace, and I venture to suggest that natural hybridisation is the most rapid of nature's means towards that end.

C. C. HURST.

THE MEETINGS OF THE BRITISH AND FRENCH ASSOCIATIONS IN 1899.

THE meeting of the British Association next year, as we have already announced, will be held at Dover contemporaneously with the meeting of the Association Française at Boulogne, in order that the two bodies may interchange visits. It has been arranged that the visitors from France shall cross over to Dover on Saturday, September 16, and that the return visit of the members of our Association shall take place on the following Thursday. The arrangements on both sides of the Channel, for the reception of the visitors, are not yet completed; but we understand that while the members of the British Association are at Boulogne, the interesting ceremony of inaugurating a statue of our poet Campbell will take place; and that, at Dover, Dr. Charles Richet, the distinguished professor of physiology in the University of Paris (Faculté de Médecine) has consented to deliver one of the evening discourses. Dr. Richet's interesting reply to the official request, which was sent to him through Dr. Michael Foster, the President-elect, is as follows:

Cher maître et collègue,—Je suis trop honoré par la demande que vous me faites pour ne pas accepter immédiatement et sans réserves. Je ne sais pas encore le sujet que je prendrai; nous avons le temps d'en parler.

Si j'accepte ainsi avec joie, c'est que je considère comme vous les dissentiments qui ont séparé et qui séparent nos deux pays, faits pour s'entendre et pour s'aimer, comme absurdes et même criminels. Alors, dans la faible mesure de mes forces, je ferai tout ce qui est en mon pouvoir pour dissiper ces malentendus, et tacher d'apaiser ces haines.

Paris, Décembre 9. CHARLES RICHET.

We trust that these visits will in no small degree contribute to bring about the result which Dr. Richet so earnestly expresses.

NOTES.

THE Prince of Wales presided at a meeting held at Marlborough House on Tuesday in furtherance of the objects of the recently-formed National Association for the Prevention of Consumption. Sir William Broadbent explained the nature and means of prevention of tuberculous disease, and stated that the objects of the Association were (1) to educate the public as to the means of preventing the spread of consumption from those already suffering from the disease; (2) to extinguish tuberculosis in cattle; (3) to promote the erection of sanatoria for the open-air treatment of tuberculous disease. Lord Salisbury moved the following resolution approving of these objects:—"This meeting desires to express its approval of the effort which is being made by 'The National Association for the Prevention of Consumption and other Forms of Tuberculosis' to check the spread of the diseases due to tubercle, and to promote the recovery of those suffering from consumption and tuberculous disease generally. It also commends the method adopted by the Association of instructing public opinion and stimulating public interest rather than the advocacy of measures of compulsion." The resolution was seconded by Sir Samuel Wilks, the President of the Royal College of Physicians, and carried unanimously. Sir William Broadbent announced that the London partners of Messrs. Werner and Beit have undertaken to erect and equip a sanatorium for tuberculous patients at an estimated expense of 20,000*l.*, the construction and management of which will be under the guidance of the Association. The organising committee have every reason to congratulate themselves on the interest which has been excited in all parts of the country. Branches are being formed in York, Norwich, Ipswich, Huddersfield, and other towns, and at York a considerable sum of money has already been raised for the erection of a sanatorium.

THE Paris correspondent of the *Times* announces that at the annual sitting of the Academy of Sciences on Monday the Lalande prize was awarded to Dr. S. C. Chandler, the Damoiseau prize to Mr. George Williams Hill, and the Houllevique prize to Mr. Branly.

THE death is announced of Prof. H. W. Vogel, the distinguished professor of photography, photo-chemistry, and

spectroscopy at the Berlin Technical High School. Prof. Vogel was born in the year 1834, and he devoted his working life and energies to the advancement of photography.

Prof. Behring, together with Dr. Ruppel, is reported by the Berlin correspondent of the *British Medical Journal* to have applied for a German patent for a tuberculosis serum. His claim is: "A method for producing a highly poisonous and immunifying substance from tubercle bacilli, or from cultures of tubercle bacilli."

Mr. Borchgrevink, and the members of the Antarctic expedition under his charge, sailed from Hobart on Monday.

We learn from the *Lancet* that Luigi Galvani, the great anatomist of the Bolognese school, and better known for his discovery of animal electricity, received on Sunday, December 4, at Bologna, the honour of a centenary celebration—that of his death, which took place on December 4, 1798. The occasion evoked the presence of the leaders of the local medical school, and its orator was Signor Erminio Vitta, representing the Committee of Italian telegraphists now organising a similar commemoration of Alessandro Volta. The proceedings were highly successful.

On Monday evening Prof. Ramsay delivered a lecture, by special invitation, to the members of the Berlin Chemical Society in the Chemisches Institut, on "The New Gases and their Relations to the Periodic Law." Prof. Liebermann presided, and in the crowded audience were Prof. Virchow, Prof. Liebreich, Prof. von Bezold, Prof. Warburg, Prof. Fischer, and many other eminent men of science. The German Emperor and Empress visited the Chemisches Institut on Tuesday afternoon, in order personally to listen to a private exposition by Prof. Ramsay of his discoveries and methods.

It has already been announced that the Geological Society has decided to undertake the publication of the manuscript in its possession of a portion of the third volume of Hutton's "Theory of the Earth," and to accept the generous offer of Sir Archibald Geikie to edit and prepare it for the press. The third volume will be printed in the style of the first and second volumes of the same work, and will contain about 300 pages. The manuscript is now ready to go to the printers, and, as only a limited number will be issued, the Secretary of the Society would be glad to receive the names of intending purchasers.

The Rome correspondent of the *Daily Mail* reports as follows:—Some very important discoveries have recently been made in the Vatican library. While examining some State documents of the sixteenth century, the Abbé Cozza Luzzi, assistant librarian, had the good fortune to find the original manuscript treatise by Galileo Galilei on the tides. The manuscript, which was hitherto only known as N 8193, is all in Galileo's own handwriting, and ends with the words:—"Written in Rome in the Medici Gardens, on January 8, 1616." The great astronomer had dedicated the book to Cardinal Orsino, his admirer, and Mæcenas. Leo XIII. has taken the greatest interest in the discovery, and has ordered the manuscript to be published in an elegant edition at the expense of the Vatican. The discovery of this treatise, the original of which was considered lost, is all the more important as it differs considerably from the text hitherto accepted as Galileo's, and now in course of publication, together with Galileo's complete works, by the Accademia della Crusca.

Science publishes some particulars in regard to the forthcoming meeting of the American Society of Naturalists, and of the Societies holding their meetings in New York City in conjunction with it. The first meeting of the Society of Naturalists will be in the American Museum of Natural History on December 28. After a welcome by the President of the Museum, Mr. Morris K. Jesup, Prof. Henry F. Osborn will give a lecture on "Collections of Fossil Mammals and their Care." The chief meeting of the Naturalists will be held on the afternoon of December 29 at Schermerhorn Hall, Columbia University. After the Societies have been welcomed by President Low, a series of short papers will be read on "Advances in Methods of Teaching," as follows:—Zoology, Prof. E. G. Conklin, University of Pennsylvania; anatomy, Prof. George S. Huntington, Columbia University; physiology, Prof. W. T. Porter, Harvard Medical School; psychology, Prof. Hugo Münsterberg, Harvard University; anthropology, Dr. Franz Boas, Columbia University; botany, Prof. W. F. Ganong, Smith College.

At the end of last year the Council of the German Chemical Society appointed a Commission, consisting of Profs. Landolt, Ostwald and Seubert, to draw up a table of atomic weights for use in calculations incident to the practice of analytical chemistry. The report of the Commission is to be found in the last number of the *Berichte*. It is decided to take oxygen as 16·000, and to select atomic weights for other elements in direct or indirect comparison with this value. It is noteworthy that Prof. Seubert, who has hitherto stood out for hydrogen (1·000) as the proper basis for atomic weights, now concedes that for practical purposes oxygen as 16·000 is the more suitable standard. Hydrogen thus becomes 1·01. In the table as printed the atomic weights are not given beyond the last trustworthy figure, and in no case beyond the second decimal place. Nickel is given at 58·7, cobalt as 59; but these numbers are marked as open to some doubt. It is proposed to print the table annually in the *Berichte*, with any revision that may be found necessary. The wish is expressed by the Commission that there should be some international understanding on the subject of the atomic weights used in analytical chemistry; and it is remarked that the achievement of this would not be difficult, since the German table is practically the same as that issued in America by Prof. F. W. Clarke on behalf of the Atomic Weight Commission of the United States. The Council of the Society have requested the Commission to open international negotiations.

The two following items of news give support to the case for the adoption of the metric system in this country:—The Board of Trade have received information that a large amount of ironwork for bridges in Norway has been ordered from Antwerp. The contractors state that they would gladly have placed the order in England, but have lately gone over to order all their iron from the continent, because they cannot get English makers to supply the work according to the metric system, and it is too complicated for them to work it all out into English measurement, feet and inches.—At a recent meeting of the Bristol Chamber of Commerce it was unanimously resolved: "That the Council of this Chamber, in view of the repeated warnings of H.M. Consuls, and deeply sensible itself of the injury done to British trade by the delay in the adoption of the metric system of weights and measures by this country, strongly urges the Government and all public bodies to aid in making the system familiar to the public, by making use of it in their various contracts, returns, and reports."

Upon the subject of mosquitoes and malaria, the *British Medical Journal* publishes the following note:—We learn on trustworthy authority that the Italian investigators have once again succeeded in conveying to man malarial infection by means of mosquito bites. The parasite in this instance was the benign tertian; the mosquito employed was the same as that which has already proved an efficient transmitter of the malignant tertian

parasite—namely, *Anopheles claviger*. In this second successful experiment the mosquitoes were brought from a distance from a notoriously malarial spot, and liberated on the subject of the experiment in Rome. The investigators referred to have not yet discovered Ross's "germinal rods" in mosquitoes purposely fed on crescent-containing blood. We hear, however, that they have found these rods in mosquitoes brought from a distance from houses in which there had been malarial fever cases.

Mr. W. Garstang's paper on the variation, races, and migrations of the mackerel (*Scomber scomber*), published in the latest number of the *Journal* of the Marine Biological Association, is a valuable contribution to a subject of economic as well as of scientific importance. The investigation was undertaken at the invitation of H.M. Treasury, and its chief object was to discover the relation to one another of the spring and autumn schools of mackerel which regularly visit the Irish coasts. In the spring a multitude of large fish approach the south and west coasts of Ireland to breed. In the autumn, schools of immature, but usually well-grown, mackerel come around the island. These differences are explained by the facts collected by Mr. Garstang; for it appears that the Irish race of mackerel may be subdivided into two distinct stocks.

The paramount conclusion of the inquiry of Mr. Garstang into the life-history of the mackerel is thus expressed: "The mackerel which frequent British waters are not exactly alike in all localities, but possess certain average peculiarities which distinguish one local race from another. These peculiarities are greatest between the races of localities which are geographically remote, and least between those which occupy areas that are geographically contiguous. Between the mackerel of the North Sea and English Channel there are no differences at all; but the Irish race is distinctly divisible into two stocks, one of which is restricted to the west coast, the other to the south. A considerable amount of mixture takes place between the southern Irish stock and the fish which frequent the mouth of the English Channel. The western Irish stock represents more closely than any other race the primitive type of mackerel, from which all, whether British or American, have been derived." It is pointed out that the establishment of geographical or local races of the mackerel involves the rejection of the theory of long migrations.

An abstract of a study of the more stable differences of a physical nature which exist between white and negro children of the same sexes and the same ages, is given by Dr. A. Hrdlicka in the *American Anthropologist* (November). It appears that, in a general way, white children present more diversity, negro children more uniformity, in all their normal physical characters. This becomes gradually more marked as age increases. As to physical abnormalities, those of congenital origin are much less frequent in the negro child than in the white one. With acquired abnormalities, principally the result of rachitic conditions, the case is almost the reverse, those characters being less frequent in the white children.

A recent number of the *Arbeiten aus dem Kaiserlichen gesundheitsamt* contains a series of reports drawn up by medical officers resident in different parts of German East Africa. These reports are furnished in response to a circular issued by the Colonial Medical Department, containing a list of various subjects upon which it was desired to collect information. Amongst these we find vaccination, the surgical treatment of various wounds, &c., the treatment of mental diseases; whilst special attention is directed to the collection and identification, where possible, of herbs and roots employed for medicinal purposes by the natives. As a result of this circular an immense amount of most valuable and instructive information has been collected, which not only should prove of use, but is also of great interest from an historical point of view, throwing as it does considerable light on the social conditions of these natives. Some curious medical superstitions are recorded, such as the treatment of stings from scorpions by burning the sting of the insect and placing its ashes on the wound; whilst, in the absence of this remedy, salt and snuff are to be rubbed in! The mentally afflicted suffer most from the effect of superstition, however, and have to submit to what can only be described as the most cruel torture to procure the ejection of the evil spirit with which the patient is believed to be possessed. The perpetuation of the race does not seem to be regarded as of much importance, and in the case of one tribe when twins are born, one is always destroyed, usually the last born, except where both sexes are represented, under which circumstance the female is invariably sacrificed. Nothing but praise can be accorded to the enterprising spirit of the German Colonial Department, which is not alone ambitious to extend its dominions, but is equally concerned in obtaining all the information it can about the possessions which it has already acquired.

Among the subjects of papers read at the recent conference of the Society for the Protection of Birds, was the decrease in the numbers of swallows and martins coming to this country, by Mr. J. H. Allchin. One of the causes of this decrease is that swallows are netted by the thousand as they came to the shores of Italy in their northward migration, and are eaten as food; they are also caught in great numbers with artificial flies and fish-hooks; all this being contrary to the Italian law and to treaty with the European Powers, which binds Italy not to permit the netting of birds on her shores. As regards destruction of swallows on the southern coast of France, records in official publications testify to the massacre of millions, while on their passage, by means of the net, the fish-hook, and the electric wire. The chief disturbing element in England is the common house sparrow, which persecutes the house martin, ejecting it from its nest, and destroying eggs and young. Mr. Allchin proposed that the Society should present a strong protest to the Governments of Italy and France against the destruction of birds in the course of their annual migrations, and should also petition the Board of Agriculture to send a protest to the aforesaid Governments, on the ground that the destruction of the Hirundinidae and other insectivorous birds was diminishing their numbers to such an extent as to lead to a serious increase of insects injurious to our crops. He further suggested that means should be taken to destroy the eggs (but not the nests) of house sparrows, and that County Councils be petitioned to place all swallows and martins and their eggs on the protected list, and to extend the close season to the full extent of the birds' stay in this country.

Dr. Tollenaar, writing from Batavia with reference to the alleged momentary increase of temperature in one end of a bar of metal suddenly cooled at the opposite end, calls attention to the fact that the matter was investigated sixty years ago by Schröder in a paper entitled "Kaun die plötzliche Abkühlung eines Theiles einer erwärmten metallische Masse eine plötzliche Temperatursteigung eines anderen Theiles zur Folge haben?" (*Pogg. Ann.*, 46, p. 135.) In our correspondence columns will be found a letter (p. 174), in which it is stated that there is no increase of temperature in the bar when one end is cooled.

Dr. G. Ercolini contributes to the *Atti dei Lincei* (vii. 8) a note on the variations produced in the dielectric constant of glass by mechanical traction. The experiments, which agree with those of Quincke, serve to verify Lipmann's theory that the dielectric constant of glass increases with traction. The greater the tension the more closely is the increase in the constant proportional to it; at first it falls short of proportionality.

UNDER the somewhat ambitious and comprehensive title, "On kathodic rays, on Rontgen rays, and on the size and density of atoms," Signor G. Guglielmo discusses in the *Atti dei Lincei*, vii. 8, that much debatable point, the nature of Röntgen rays. The author favours the hypothesis that these rays are due to non-periodic disturbances of the ether; and seeing that the impact of kathodic rays produces in bodies a regular vibration which is fluorescence, Röntgen rays may be due to the ether entrained by the particles of the kathodic rays, and set free when these particles are brought to rest.

In the *Journal* of the Royal Statistical Society (lxi. iii.) Prof. F. Y. Edgeworth is endeavouring to show that the higher theory of probabilities is not restricted to organic nature; but the law of error is fulfilled in social life also, whenever a great number of independent causes act. Remarking that the multifarious motives which sway voters at a contested election may be expected to produce results dispersed about an average according to that normal law, Prof. Edgeworth has obtained tables of the ratio of Unionists to Gladstonians, and Unionists combined in each English constituency for the three last general elections. The grouping of these ratios shows a certain approximation to the normal form. Prof. Edgeworth also discusses the reasons for selecting the above-named ratio as the attribute to be tabulated, and shows that the values of this ratio lie more symmetrically between the mean and the extremes than those of other ratios which might be suggested.

THE report on the Administration of the Meteorological Department of the Government of India in 1897–8 shows that the observatories, 174 in number, remain practically the same as in the previous year. In order to give early information of the advent and progress of the south-west monsoon, a daily telegram was received from the Seychelles Islands from May to July. Actinometric observations have been continued as in the eight previous years, and have been sent to the Solar Physics' Committee in London. The day of the total solar eclipse (January 22 last) was remarkably fine nearly all over India, and 158 observers took part in the observations. These have been tabulated and reduced, and it is proposed to publish them in detail during the ensuing year. A large number of reports of earthquake shocks have been received during past years, and copies have been sent to the Geological Survey Department; in future a brief statement of the earthquakes of each month will be published in the *Monthly Reviews*. The results of the cloud observations taken at various stations, in accordance with the scheme proposed by the International Meteorological Committee, are said to be very interesting and encouraging, and will probably throw much light on the meteorology and more massive air currents in India. The extraction of observations made in ships' logs has been continued at several ports; these are used chiefly in the preparation of daily weather charts of the Indian monsoon area. The collection of accurate information relating to the snowfall in the Himalayan and Afghan mountain areas has been continued, and enabled its probable effect in modifying the distribution of the south-west monsoon rainfall to be determined. The work of issuing storm warnings to the various ports appears to have been carried out very satisfactorily; ample notice was given of all the more important storms which visited the Indian coasts during the year in question. The selection of weather types, to aid in the issue of daily forecasts, has been under consideration, and the preparation of an atlas and handbook, with that object in view, will probably be taken up in due course, as it is considered that there are now sufficient materials in the possession of the Department for the adequate treatment of the subject.

PROF. R. H. THURSTON calls attention in *Science* to some points of scientific interest in the report of the Chief of the Bureau of Steam Engineering upon the engineering work of the navy in the war with Spain. Some work was performed with marvellous despatch. Thus, the old and worn-out "shell-boilers" of the monitors *Manhattan*, *Mahopac* and *Canonicus*, at League Island, were replaced by new constructions in thirty days. The new water-tube boilers were passed in parts through the hatches, and the old boilers were cut in pieces below and passed up in small sections. Water-tube boilers are unqualifiedly approved for naval purposes, and experience with those of the *Marietta*, while accompanying the *Oregon* on the long 14,000-mile voyage around Cape Horn, proves that such boilers are trustworthy when properly made and handled. The steam turbine is referred to, but with the statement that it is not yet certain that it will find permanent place in the naval service. The use of oil-fuels is pronounced promising in some naval work where costs of fuel are not of prime importance. Success is met with in the use of an oil of specific gravity, 0·85 to 0·87, a flash-point of 315° F., and a burning point of 350° F.

THE new volume of "Who's Who" (A. and C. Black) contains several additional features, and more than fifteen hundred new biographies, some of which refer to men of distinction in the scientific world.

A BULKY volume of "Anales de la Oficina Meteorológica Argentina" has just been received from the Director, Señor G. G. Davis. The volume is full of statistics referring to the climates of Asuncion in Paraguay, and Rosario in the Province of Santa Fé.

A NEW part of Prof. G. O. Sars' monograph on the Crustacea of Norway has just been published by the Bergen Museum. The family Oniscidae is concluded, and members of the families Bopyridae and Dajidae are described.

IN a pamphlet entitled "A Record of Study of Aboriginal American Languages," Dr. D. G. Brinton surveys his writings in this branch of linguistics, extending over a period of forty years. The papers are arranged geographically, and sufficient reference to their contents is given to indicate their aims and conclusions.

THE November (supplementary) number of the *Oesterreichische Monatsschrift für den Orient* includes an important report from Shanghai, dealing with sericiculture in China, to which we particularly call the attention of persons commercially interested in the silk trade.

THE last number received of the *Kew Bulletin of Miscellaneous Information* (designated Appendix I, 1899), is entirely occupied by the annual list of seeds of hardy herbaceous plants and of trees and shrubs, which the Department offers in exchange with Colonial, Indian, and foreign botanic gardens, as well as with regular correspondents of Kew.

THE United States National Museum has just published a large paper of nearly two hundred pages, with twenty-two plates, by the indefatigable entomologists, Drs. John B. Smith and Harrison G. Dyar, including a revision of the species of *Acronycta* (Ochsenheimer) and of certain allied genera. With this paper is issued a set of seven coloured plates of moths and larvæ belonging to the same group, which were prepared to illustrate an unfinished paper intended to be issued by the Department of Agriculture.

PART I. of the *Proceedings* of the South London Entomological and Natural History Society for 1898 is chiefly devoted to *Lepidoptera*. The most important paper is one by Mr. J. W. Tutt, on the British *Lasiocampidae*, containing a hypothetical phylogenetic tree of the genera, and another exhibiting the phylogeny of super-families of the Sphingo-Micropterygid

stirps. There are also notes by Mr. R. South, on British *Lepidoptera* occurring in Japan; and by Mr. A. H. Jones, on some South European *Lepidoptera*, with remarks on the genera *Thais* and *Euchloe*. The only paper relating to a different order is by Mr. E. Saunders, on collecting British *Hemiptera*.

THE Royal Society for the Prevention of Cruelty to Animals has sent us the twenty-ninth annual volume of "The Animal World," and a new volume of the "Band of Mercy." Both volumes are profusely illustrated with pictures of animals, and they will assist the educational work of the Society. Children interested in animals or natural history—and what children are not?—would regard either of the volumes as an acceptable present for Christmas or the New Year.

THE twenty-first volume of *Knowledge*, containing the monthly parts published during the current year, has been received. The articles in the volume deal with many scientific subjects, but the most prominent features are astronomy and natural history. The chief contributors are Mr. R. Lydekker, who writes on various zoological matters; Prof. Grenville Cole, who deals with a number of geological structures and problems; Mr. A. Vaughan Jennings, who contributes a series of botanical studies; and Mr. E. W. Maunder, who writes on interesting astronomical objects and events. Numerous illustrations, many of them full-page plates, and including reproductions of several of Dr. Roberts's marvellous photographs, adorn the pages of the volume.

MR. WILLIAM MARRIOTT informs us that on January 2, 1899, the offices of the Royal Meteorological Society will be removed to Princes Mansions, 70 Victoria Street, Westminster, S.W., to which address all communications, on and after that date, should be forwarded.

THE Tidal Survey branch of the Department of Marine and Fisheries of the Dominion of Canada has issued a collection of tide-tables for Halifax, Quebec, and St. John, for the year 1899, with tidal differences for the Atlantic coast of Nova Scotia, and for the St. Lawrence River, from Three Rivers to Gaspe.

PSYCHOLOGISTS and students of the philosophy of science will be interested in the announcement that, under the title of "Truth and Error, or the Science of Intellection," Messrs. Kegan Paul, Trench, Trübner, and Co., Ltd., will shortly publish a new book by Mr. J. W. Powell, the Director of the United States Bureau of American Ethnology, and sometime Director of the United States Geological Survey.

THE Tuesday evening penny science lectures will be resumed at the Royal Victoria Hall, Waterloo Bridge Road, on January 3, when the Rev. R. H. Whitcombe will discourse on "Science Jottings in Switzerland." On January 10, Mr. R. A. Gregory will lecture on "Astronomy before Telescopes"; and on January 17, Prof. Farmer will lecture on "Plants as Engineers." On January 24, Mr. C. W. Andrews will give an account of his work on "Christmas Island"; and on January 31, Prof. Frank Clowes will lecture on "Old Father Thames."

A NUMBER of forthcoming works on scientific subjects appear in the *Book Circular* (No. 69, Scientific Series), just issued by Messrs. Williams and Norgate. Among the volumes announced we notice the following:—The second volume of Dr. F. Dannemann's "Grundriss einer Geschichte der Naturwissenschaften," entitled "Geschichte der Naturwissenschaften aller Völker und Zeiten."—Prof. Ernest Haeckel's lecture to the Fourth International Zoological Congress at Cambridge will be issued, with notes and tables, under the title "Unsere gegenwärtige Kenntniss vom Ursprung des Menschen."—Another work by Prof. Haeckel, which is announced for publication in January, is "Kunstformen der Natur."—A work by Prof. O. Bütschli, Professor of Zoology at Heidelberg, being a continuation of the same author's "Untersuchungen über microskopische Schäume," of which an English translation has been issued.—The second part of the second volume of Dr. Paul Knuth's "Handbuch der Blüten biologie," containing Lobeliaceæ to Coniferæ.—M. Riban, of the University of Paris, has prepared a "Traité d'analyse chimique quantitative par l'Electrolyse."—"La photographie animée," by E. Trutat, Director of the Natural History Museum of Toulouse.—A work by Prof. Lebon, of the Lycée Charlemagne, Paris, entitled "L'Histoire abrégée de l'Astronomie."—A volume by M. E. Bouty, Professeur de la Faculté des Sciences, on "Electricité à ondes Herziennes. Rayons X."

THE additions to the Zoological Society's Gardens during the past week include two Red-bellied Squirrels (*Sciurus variegatus*) from Trinidad, presented by Master Lawrence; a Palm Squirrel (*Sciurus palmarum*) from India, presented by Dr. G. Lindsay Johnson; a Pluto Monkey (*Cercopithecus leucampyx*, ♂) from Congoland, deposited; a Nutcracker (*Nucifraga caryocatactes*), a Common Sheldrake (*Tadorna cornuta*) European, purchased.

OUR ASTRONOMICAL COLUMN.

A TOTAL ECLIPSE OF THE MOON.—On Tuesday next (December 27) the moon will pass entirely into the shadow of the earth, and be totally eclipsed. The following are some of the particulars which may be useful to those who wish to observe this phenomenon, but fuller information, together with a list of stars to be occulted, will be found in the *Nautical Almanac* and the *Companion to the Observatory*.

	h. m.
First contact with the penumbra, Dec. 27,	8 26·5 G.M.T.
,, ,, shadow ...	9 39·4
Beginning of total phase ...	10 49·0
Middle of the eclipse	11 33·7
End of total phase	12 18·4
Last contact with the shadow ...	13 28·0
,, ,, penumbra	14 40·9

The moon meets the shadow at a point on her limb which is 112° from her north point towards the eastern side, and passes out at a point 95° towards the west.

The magnitude of the eclipse is represented as 1·383, the unit representing the case when conditions are such that the moon is only just able to be totally immersed for an instant.

COMET CHASE.—This comet, which is gradually brightening, is situated in the constellation of Leo Minor, and lies slightly to the north of the 6th magnitude star 50 in Leo Minor. The following is the ephemeris to the end of the present month.

1898.	R.A. (app.) h. m. s.	Decl (app.) ° ′	Br.
Dec. 22 ...	10 55 11 ..	+26 59·8 ...	1·39
24 ...	56 44 ...	27 19·0 ...	,,
26 ...	58 11 ..	27 38·8 ...	,,
28 ..	10 59 31 ...	27 59·0 ...	,,
30 ...	11 0 43	+28 19·7 ...	1·39

COMETS *i* 1898 AND 1881 IV.—Writing in the *Astronomical Journal* (Nos. 448–450), Dr. Perrine, of the Lick Observatory, points out a distinct relationship between the comet *i* 1898 and 1881 IV. The similarity of the orbits is strikingly seen from the following comparison of the orbits:—

Comet.	ω	Ω	*i*	*q*
i 1898 ...	... 122 8 ...	97 17 ...	140 14 ...	0·6335
1881 IV....	.. 123 22 ...	96 10 ...	140 19 ...	0·7564

Dr. Perrine states that although it is not possible for Brooks's comet to be a return of Schaeberle's, yet the resemblance is so close that a strong family connection is indicated. If we may be permitted to make a suggestion, might not there be two comets pursuing the same path? Just as comets are thinned out by their component parts lagging behind and following, so

to speak, in their wake, may not the first comet have undergone considerable perturbations and internal action, causing the original assembly of particles to separate into two or, perhaps, more portions? We should thus have two comets pursuing the same path, but passing perihelion at different times.

EPHEMERIS OF PLANET 1898 DQ.—We give below an ephemeris for Witt's planet for the remainder of this month. The planet is of the 12th magnitude, and will be found in the constellation of Aquarius, a little to the north of the stars η and ζ Aquarii.

1898	R.A. (app.) h. m. s.	Dec. (App.) ° '
Dec. 21	22 26 11	+1 31·8
23	30 35	1 54·2
25	35 2	2 17·0
27	39 32	2 40·3
29	44 5	3 4·0
31	22 48 40	+3 28·2

THE COMPANION TO THE OBSERVATORY FOR 1899. This handy little *vade-mecum*, which contains in a condensed form the more useful data that are of more general interest in observational astronomy, has just been issued. As the introduction states, "the present 'Companion' closely resembles that of last year," and a brief perusal of its contents does not lead us to state otherwise. Mr. Denning, as usual, is responsible for the meteor notes, and Mr. Maw has supplied numerous observations of double stars. The variable-star ephemerides have been obtained from M. Loewy's "advance-proofs," and Mr. Crommelin has communicated the list of stars which will be occulted by the moon during the lunar eclipse of December 16.

THE SOLAR DISC DURING 1897.—The solar observatories at Dehra Dun, Mauritius, and Greenwich, give us between them pictures of the disc of the sun 364 days out of the 365 in the year. We have thus practically a daily record of the spots that appear on the solar disc that is absolutely unique in astronomical photography. As we are approaching, as far as we know, a period of minimum sunspots, which, in other words, means a more quiescent state of the solar atmosphere, spots are getting less numerous, and their latitudes are becoming lower. A general summary of an examination of such photographs, as mentioned above, for the year 1897 (*Monthly Notices.*, *R.A.S.*, vol. lix. No. 1), shows that there has been a slight decrease in the daily spotted area as compared with the preceding year, the rapidity of the decline which set in after 1893 having now received a check; the decrease in faculæ has been quite considerable. The most noticeable feature has been the reduction of the mean distance of the spots from the equator. For the four preceding years the distance was 14°, but for 1897 it was not quite 8°. In both hemispheres the decline in latitude has been irregular. In the northern hemisphere the decline was very great for the first six months of the year, and was accompanied with a great decrease in spots. A secondary revival and subsequent decline and revival terminated during the year. A similar but less pronounced movement occurred in the southern hemisphere. The observations of the sun during the current year have shown that the spotted area has begun somewhat to increase again; but whether this is an indication that the minimum is now passed, or that only a temporary revival is taking place, cannot be definitely stated.

THE MELBOURNE OBSERVATORY.—The thirty-second report of the Board of Visitors to the observatory, together with the report of the Government astronomer, Mr. P. Baracchi, for the period included between July 1, 1897, and June 30 of the present year, show that the observatory is in good working order. With regard to the position of Mr. Baracchi, the Board says: "We regret to find that the Acting Astronomer still occupies the anomalous position he has occupied since he has had charge of the Observatory: his salary being that which he enjoyed prior to the retirement of Mr Ellery, and we venture to hope that the Government will soon be able to appoint Mr. Baracchi to the full position of Government Astronomer, with the emolument fixed thereto under the Public Service Act." Mr. Baracchi's report shows that the observatory has been very busy during the past year. The appointment of a new assistant has led to a slight change in the distribution of the work, which has proved advantageous. The meridian work and reduction has been extensive, and the usual time and meteorological service continued. Considerable progress has been made with the astrophotographic work, the catalogue plates being now complete and the chart plates numbering 278. By an arrangement with Mr. H. C. Russell, the Government Astronomer of New South Wales, Mr. Baracchi has decided to have all the work of measuring and reducing the plates of the photographic catalogue of the two zones done at the Melbourne Observatory, the two Colonies sharing the expense. The proposal that four young assistants, directed by one of the officers of the Melbourne Observatory, should be employed on this work, has already been sanctioned, and the work will be commenced as soon as the appointments have been made. The Victorian Government has placed on the estimates for the current financial year a sum of money for dealing with the observations in terrestrial magnetism at the Melbourne Observatory for the past thirty years. A discussion of such a fine series of observations should be of great value.

THE RELATION OF THE TOXIN AND ANTI-TOXIN OF SNAKE VENOM.

EARLY in the present year a paper on this subject, by Drs. C. J. Martin and Cherry, appeared in the *Proceedings* of the Royal Society (vol. lxiii. p. 420). A short summary of their experiments and conclusions was given in these columns. A supplementary paper has just been published by Dr. Martin (*Proc. Roy. Soc.*, vol. lxiv. 88), in which further experiments on this most important subject are detailed. They confirm the conclusions previously arrived at, that the antagonism between the toxins and anti-toxins is a directly chemical one, and is not, as Calmette and others state, due to an interaction solely produced by the agency of the cells of the organism into which these substances enter.

The present experiments were performed with the snake venom derived from the Australian tiger-snake *Hoplocephalus curtus*); the anti-venene employed was prepared by Dr. Calmette; and rabbits were selected as the subjects of the experiments. The results obtained are not only of practical importance in the treatment of snake-poisoning, but are of special interest, as they bear on the relations of toxins and anti-toxins in general. In snake venom and its antidote we possess substances of which the chemical nature is fairly well understood. A knowledge of their action (which must be regarded as typical of the whole class of toxins and anti-toxins) furnishes the key to the unlocking of the problem in diphtheria and other diseases, where the chemical investigation of the actual agents is a much more difficult matter, since they are diluted and obscured by the other constituents of the blood and body juices.

Dr. Martin finds that about the same quantity of anti-venene necessary to neutralise the venom *in vitro*, is capable of doing so also when the former is injected into the blood-stream, and the latter subcutaneously. Solutions of the two substances can be titrated against each other just like standard solutions with the life of a rabbit as an indicator. If anti-venene is introduced into the blood-stream, it is there ready to neutralise the toxin as it is absorbed from the subcutaneous tissues, and the amount found necessary by titration outside the body is just about adequate to neutralise the toxin as it makes its appearance in the blood. To be quite exact, a slighter proportion of anti-toxin is necessary under these circumstances, and this result is no doubt due to delayed chemical action owing to the dilution of the anti-toxin in the blood.

When, however, both venom and anti-venene are introduced into the body subcutaneously, Martin finds, as Fraser originally stated, that at least ten to twenty times the quantity of anti-venene must be used to neutralise the toxin. This apparent contradiction of the results first given is really a confirmation of the views of Martin and Cherry. In the first place, it necessitates the inference that anti toxin is comparatively slowly absorbed from the subcutaneous tissues. Calmette has stated that the exact contrary is the case, but adduces no experimental proofs of his statement. Brodie's (*Journ. of Pathol.*, 1897) work with the toxin and anti-toxin of diphtheria entirely confirms Martin's experiments with tiger-snake venom.

Our chemical knowledge of toxins and anti-toxins, together with what is known of the physiological mechanism of absorption, is quite in accordance with the view that anti-toxin is only capable of slowly penetrating the capillary wall, whereas the toxin passes through fairly rapidly. The toxins, both in the case of snake poison and diphtheria, are albumoses; they dialyse

slowly in dialysers constructed of vegetable parchment; they can be filtered through a gelatin film under pressure; but experiments show they are rapidly absorbed by the blood-vessels. In other words, though their molecules are large, they are not so large as those of the native proteids.

The walls of the capillaries are membranes possessed of permeabilities approximating those of a film of gelatin, and are relatively, although not absolutely, impermeable to proteids (Starling, *Journ. of Physiol.*, vol. xix. p. 311). If molecular size is the obstacle to proteid absorption from subcutaneous spaces, the same would apply to anti-toxins, for these are substances of great molecular size comparable to proteids.

The practical indication of this in the treatment of snake-bite is to inject the anti-venene intravenously, until the potency of the anti-venomous serum which is at the disposal of the public is greatly enhanced.

W. D. H.

REMARKABLE EFFECT OF THE INDIAN EARTHQUAKE OF JUNE 12, 1897.

A REMARKABLE example of the effect of the Indian earthquake of June 12, 1897, upon railway lines is illustrated by a brilliant photo-etching in the general report of the operations of the Survey of India during the years 1896-97, prepared under the general direction of Major-General C. Strahan, R.E., and recently distributed. The picture (Fig. 1), which represents the Manshai Bridge, Cooch Behar State Railway, after the earthquake referred to, is here reproduced in a reduced form.

This earthquake continues to be the theme of discussion by seismologists. One of the most important papers yet published is that by Dr. Agamennone in the last *Bollettino* (vol. iv., No 3) of the Italian Seismological Society, of which the following is a summary. At Rome, the early short-period vibrations were first recorded at 11.17 a.m. (G.M.T.), and these lasted until about 11.40, when the long-period pulsations commenced, reaching a maximum at about 11.47½. During the first interval there were five distinct maxima, all of which can be identified with those on the records from other observatories. After 11.47½ these records fail to show marked features in common, and the movement dies away more or less slowly according to the sensitiveness of the instrument employed. At Calcutta, the duration of the earthquake is variously estimated at from four to ten minutes, and at Shillong, which is close to the epicentre, at two minutes. In Europe, the duration of the disturbance, according to magnetograph records, was about half an hour at St. Petersburg, 1¼ hours at Wilhelmshaven, and 2¼ hours at Utrecht; and, according to those of different Italian seismometrographs, 1½ hours at Verona, 1¾ hours at Rome, 3 hours at Catania, and 3¼ hours at Padua. At Rome, the period of the earliest vibrations was half a second, but this gradually increased to 3·3 seconds after about 15 minutes. The pulsations which followed had a period of 11 and 10 seconds, in the records of pendulums 16 and 8 metres long, respectively, decreasing to about 8 seconds in both; and it is interesting to notice how closely the different instruments at other observatories agree in this respect. The measures of the maximum tilt of the ground during the passage of the pulsations are less concordant, but the mean of eight good observations in Italy is 12''·4, a value which agrees fairly well with that of 10'' obtained by means of the bifilar pendulum at Edinburgh. Unfortunately, for the calculations of the velocity, the recorded times at Calcutta differ by 2½ minutes, being 11.4½ (La Touche) and 11.7 (Oldham). Dr. Agamennone quotes nineteen European records of the time of the first disturbance, and the five best give a mean velocity of 9 or 11 km. per second, according to the time adopted for Calcutta. For the long-period pulsations, the corresponding estimates are 2·6 and 2·8 km. per second, *i.e.* about one-quarter of the above. Lastly, taking the period of the pulsations at 10 seconds, the velocity at 2·7 km. per second, and the maximum tilt of the ground at 12'', Dr. Agamennone finds the length of a complete pulsation, as it traversed Italy, to be 54 km., and the height of its crest (or amplitude) about half a metre.

FIG. 1.

BRITISH ASSOCIATION.

CONFERENCE OF THE DELEGATES OF THE CORRESPONDING SOCIETIES.

THE first meeting of the Conference was held at University College, Bristol, on Thursday, September 8, at 3 p.m. The Corresponding Societies' Committee were represented by Mr. W. Whitaker (Chairman), Dr. Garson, Mr. Hopkinson, Prof. Meldola, Mr. G. J. Symons, and Mr. T. V. Holmes (Secretary).

A short report, which was in the hands of every delegate present, contained the following paragraph:—

The Committee observe with satisfaction that the corresponding societies steadily increase in number, and that the total number of the members composing them also increases. For example, in the British Association Report of the Bath meeting in 1888 there is a list of fifty-five corresponding societies, having a total of 18,950 members. The Toronto Report of last year shows sixty-nine corresponding societies, having a total of 22,395 members. On the other hand, the average number of members in each society appears to have slightly decreased, having been between 344 and 345 in 1888, and between 324 and 325 in 1897. But this is accounted for by the collapse of the two federations—the Midland Union and the Cumberland and Westmoreland Association—and the withdrawal of the Royal Scottish Geographical Society between the two periods. For in 1888 these three associations numbered among them 4006 members, as many as would be found in eleven or twelve average societies.

The Committee, while regretting the absence of certain societies whose headquarters are not in London from the list of corresponding societies, add:—Fortunately, in most cases.

information as to the titles and authors of papers read before local societies not corresponding societies of the British Association may be obtained from the "Official Year-book of the Scientific and Learned Societies of Great Britain and Ireland" (C. Griffin and Co., London). The "Year-book" appears every spring, and contains lists of papers read in the previous year. It will be found that the "Year-book" and the British Association "Index" combined leave little to be desired by the inquirer after papers on any locality in the British Isles.

The following societies have been added to the list of the corresponding societies:—The Hull Geological Society, the South-Eastern Union of Naturalists' Societies, and the Astronomical and Physical Society of Toronto.

Mr. Whitaker opened the proceedings by introducing the subject of coast erosion. He remarked on the much greater ease and accuracy with which measurements of the amount of loss could be made now that maps on the scale of 6 inches to the mile were obtainable for all parts of the country. He instanced Sheppey as a good example of a place at which loss by coast erosion had been unusually rapid. On the first visit of the Geologists' Association there, the church and churchyard of Warden were untouched: on a later occasion the churchyard was found to have been injured, and coffins were sticking out from the edge of the cliff. That year they had found neither churchyard nor church. They had also seen, during the visit last Whitsuntide of the Geologists' Association to Aldeburgh in Suffolk, an example of another kind of marine encroachment. There they found cottages, sheds and gardens more or less injured or destroyed by the heaping-up of masses of shingle in or against them, the result of a storm in November 1897. The driving inland of blown sand also caused much injury to land on the coast in certain localities. As to the economical aspect of the question, there were certainly many places from which the removal of shingle from the shore should never be allowed. Indeed it should nowhere be allowed without careful consideration as to the probable result. And the quarrying of stone on the face of a sea-cliff should seldom, if ever, be permitted.

Mr. W. H. Wheeler thought that the movement of shingle along our shores was due to the action of the tides, not of the winds. Mr. A. T. Walmisley had always advocated the protection of the shore by groynes. Sea walls should be placed a short distance in front of the cliff to be protected. Mr. Vaughan Cornish said that the protection of one part of the shore was a bad thing for the rest of the district. He thought that no local shore protection should be allowed unless sanctioned by a Government Board. In any study of the effects of coast erosion the coast-guard, if the Admiralty gave their consent, would be able to render most valuable assistance. Mr. Wheeler thought the retention of a mass of shingle in front of a place a better protection than a sea wall. He would greatly approve of an attempt to obtain the services of the coast-guard in noting coast erosion, as at present he had found it very difficult to get trustworthy evidence. Prof. Meldola moved the following resolution:—"That the Council of the British Association be requested to bring under the notice of the Admiralty the importance of securing systematic observations upon the erosion of the sea coasts of the United Kingdom, and that the co-operation of the coast-guard might be profitably secured for this purpose." After some discussion the resolution was seconded by Mr. Gray, and carried.

Prof. Meldola read a letter from Prof. W. W. Watts, stating that the Geological Photographs Committee had formed a collection of duplicate photographs and lantern slides, consisting of about 250 prints and 100 lantern slides, which could be sent during the winter to any local scientific society wishing to make use of them.

SECOND MEETING OF THE CONFERENCE, SEPTEMBER 13.

The Corresponding Societies Committee were represented by Mr. Whitaker, Dr. Garson, Rev. J. O. Bevan, Mr. Hopkinson, Mr. Symons, and Mr. T. V. Holmes (Secretary).

The Chairman (Mr. Whitaker) announced that the resolution on coast erosion, passed at their last meeting, had been submitted to the Geological and Geographical Sections, both of which had unanimously supported the recommendations contained in it. It would now be forwarded to the Council.

Prof. Silvanus Thompson had been asked to bring before the Conference the importance of adopting one or two uniform standard sizes for the pages of scientific publications. All engaged in scientific investigation were greatly indebted to their fellow workers for reprinted papers, and all recognised the advantage given by uniformity of size in allowing these papers to be bound together. The great advantages of uniformity in size had caused the formation of a British Association Committee some four years ago, whose object was to prescribe the adoption of certain standard octavo and quarto sizes. The report of this Committee would be found in the Ipswich Report (1895), p. 77. The standard octavo size there recommended was—

Paper demy, pages measuring when uncut $5\frac{5}{8}$ inches by $8\frac{3}{4}$ inches. The width, measured from the stitching to the edge of the printed matter, to be $4\frac{5}{8}$ inches, and the height of the printed portion, including the running head-line, to be 7 inches.

The standard quarto size. Paper demy, the pages measuring when uncut $8\frac{3}{4}$ inches wide by 11 inches high. Letterpress not to exceed the measurements of $7\frac{1}{2}$ inches by 9 inches. It was also desirable that each article should begin a page, and, if practicable, the right-hand page. It can then be bound with other articles without the last page of a preceding article being bound up with it. Many other details would be found in the Report of the Committee, with illustrations.

Prof. Meldola said that a glance at the shelves at Burlington House, on which the publications of the corresponding societies were collected, showed a considerable amount of diversity in size. Some societies also did themselves injustice as regards paper and printing. Mr. Hopkinson thought that the chief offenders were societies which, from want of sufficient funds, published reprints from local newspapers.

Section A.

Mr. G. J. Symons said that Prof. Milne was making important observations on earthquake tremors in an unsatisfactory house in the Isle of Wight. It had been suggested that there were houses in Richmond Park suitable for the purpose, and that it might be well to approach the Government and try to obtain one for him. Or perhaps some rich man might lend Prof. Milne a house for a few years.

Section C.

Mr. Beeby Thompson said that a fine specimen of a Dinosaur had recently been discovered near Northampton. It would, however, be a very expensive work to uncover it carefully, and he wished either to obtain a grant from the British Association for that purpose, or to induce any rich people who might hear of the case to assist in providing funds.

The Chairman thought that the matter should be brought before the scientific societies of Northampton.

Section H.

The Chairman directed the attention of the Conference to the Ethnographical Survey, an investigation in which few local societies were co-operating.

Mr. Hartland, Secretary of the Ethnographical Survey Committee, said that it would greatly help his Committee if each of the corresponding societies would take up one or more branches of the inquiry. He had explained at previous Conferences that it was by no means necessary that all branches should be taken up everywhere. He would be happy to send to all the corresponding societies all the information they might require for the purpose of carrying on the work.

The Chairman hoped that the delegates would give some account to their respective societies of the discussions which had taken place at the Conference.

The proceedings then terminated.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PROF. RÖNTGEN has decided not to accept the call to the University of Leipzig as the successor of Prof. Wiedermann, who has retired, at the age of seventy-two.

IT is announced that the Queen has conferred a knighthood on Mr. W. C. McDonald, who provided the funds for the chemistry wing to the McGill University, Montreal, which was opened on Tuesday, and has made other generous gifts to the University.

THE appointment of the Rev. T. W. Sharpe, C.B., to the Principalship of Queen's College, London, should have a decided influence upon the work of the College. Mr. Sharpe has just retired from the post of senior chief inspector and head of the administrative division of the Education Department, so he takes with him to Queen's College a wide knowledge of the principles and practice of teaching.

A USEFUL list of the current scientific serials received in Manchester, with an indication of the various libraries in which they are to be found, has been compiled, under the direction of Dr. W. E. Hoyle, by Mr. C. W. E. Leigh, and published by the Manchester Literary and Philosophical Society. The periodicals are arranged geographically, according to their place of publication. The list will doubtless prove of great service to workers in Manchester and the neighbourhood, and thus assist in the progress of science. It is believed to be the first of the kind published in England; but it is to be hoped that similar lists will be published for the use of students of science in other great cities.

SIR PHILIP MAGNUS distributed the prizes at Sexey's Trade School, Bruton, Somerset, on December 17. Alluding to prospective legislation in the direction of secondary education, he said that the County Education authorities had done their work well, and trusted there would be no rivalry between them and School Board authorities, as it would involve a risk of setting back the educational clock for many years. He pointed out the advantage of teaching a boy the manipulation of a balance and the use of tools, and attached great importance to the study of English literature. He was glad to find the school providing satisfactory scientific education in a rural district, thus embodying ideas which he had been advocating for twenty years.

IN the course of an address to the members of the Yorkshire Naturalist Union at Scarborough, on Saturday, Prof. Michael Foster, the retiring President of the Union, urged upon his hearers the great necessity of co-operation in science. All the earlier naturalists, he said, sought to solve the problems which every form of life possessed. Nature was the naturalist's teacher, and the field his laboratory. It was useless to try to stop the tide of differentiation that seemed to be creeping over the scientific world. That must go on. Still, they must look for help to go forward, not backward. Prof. Foster criticised the method of teaching science in the schools, and condemned the examinations often held as prejudicial to the development of science. The minds of students were very often pushed on by compulsion and drawn on by rewards, and no encouragement was given to them to look at nature in the fields and receive from her lips the catholic teaching which she alone could give. Such naturalists as they hoped to rear must be reared apart from the schools.

THE following gifts to educational institutions in the United States are announced in *Science*:—The Lawrence Scientific School, Harvard University, has received 10,000 dollars from Mr. J. H. Jennings, for the establishment of a scholarship.—Mr. James Stillman, of New York, has given 50,000 dollars to Harvard College to cover the cost of land and buildings for a projected Harvard Infirmary, which will bear the name of the donor. In addition, Mr. Stillman will contribute 2500 dollars annually for four years.—The will of the late Charles P. Wilder, of Wellesley Hills, bequeaths 102,000 dollars to Mount Holyoke College, and the trustees of Wellesley College announce a gift of 50,000 dollars made by Mr. Wilder before his death. No conditions are attached to the gift.—The Catholic University of Washington has received the information that by the will of Daniel T. Leahy, of Brooklyn, it receives 10,000 dollars.—The University of Cincinnati has been presented by Mr. William A. Proctor with the library of Mr. Robert Clarke, containing 6704 volumes valued at over 50,000 dollars.—A fund of 100,000 dollars is being raised by the trustees and friends of Oberlin, the income from which is to be applied to the reduction of the term bills of needy students. About one-tenth of this amount has already been collected.

THE system of payment by results of examinations, which the Intermediate Education Board for Ireland still uses in distributing its annual income of about 80,000*l.*, is made the subject of criticism by Dr. Gerald Molloy in an article reprinted from the *Irish Ecclesiastical Review*, and suggestions are made as to a general policy of reform. The following statement of facts from the article points unmistakably to the need for the reform which must soon take place:—In a memorial addressed to the Lord Lieutenant of Ireland last June, the Council of the Royal Dublin Society called attention to the way in which the teaching of science, in the intermediate schools, has been "practically exterminated" by the operation of the present system. From this paper it appears that the total number of boys that presented themselves for the examinations of the Intermediate Education Board, in the years 1887 and 1888, and the numbers that presented themselves in the subjects of natural philosophy and chemistry were as follows:—

	Total number	Nat. Philosophy	Chemistry
1887 ...	4613 ...	2611 ...	1376
1888 ...	4551 ...	2565 ...	1357

But, after the lapse of ten years, it is found that while the total number of boys presented for examination had considerably increased, the number presented in these two subjects had dwindled down almost to insignificance. The figures are:—

	Total number	Nat. Philosophy	Chemistry
1896 ...	6503 ...	618 ...	359
1897 ...	6661 ...	596 ...	312

It would seem, therefore, that something has occurred in the working of the system, during the last ten years, which has practically killed the teaching of these two important subjects in the intermediate schools of Ireland. The teaching of natural philosophy has fallen from 56 per cent. of the total number of boys presented for examination to somewhere about 9·2 per cent., and the teaching of chemistry has fallen from 30 per cent. to 4·6 per cent.

SCIENTIFIC SERIALS.

American Journal of Science, November.—Irregular reflection, by C. C. Hutchins. A carefully prepared surface of plaster of Paris, and a deposit of magnesia upon zinc, approximate very closely to Lambert's law of diffused reflection. A plaster disc cut into fine vertical furrows shows a considerable departure from the cosine law. A sphere prepared by coating an ivory ball in the flame of burning magnesium follows Lambert's equation very closely. The reflection measured is that of the total energy, observed with a thermograph and galvanometer.—Separation of nickel and cobalt by hydrochloric acid, by F. S. Havens. Pinerua's process for separating nickel and cobalt, which is analogous to the author's method of separating aluminium and iron, will not give a complete precipitation of the nickel chloride. Nickel chloride is, however, practically insoluble in pure ether saturated with HCl gas, and can be separated from small quantities of the soluble cobalt salt in that medium.—The value of type specimens and the importance of their preservation, by O. C. Marsh. The origin of mammals, by the same author. These two papers were read before the Cambridge International Zoological Congress, in August last.—Causes of variation in the composition of igneous rocks, by T. L. Walker. The author reviews briefly the more common theories advanced to explain the phenomena of variation in the composition of igneous rocks from border to centre or from top to bottom, and calls attention to the part which gravitation seems to play in causing heterogeneity in eruptive rocks. Some homogeneous salt solutions, if allowed to remain at a constant temperature for a long time, become gradually more concentrated in the lower strata. It is very probable that similar concentration occurs in complex silicate magmas, particularly near the temperature of solidification. An eruptive magma would therefore tend to become acid above and basic below. In the upper horizons of the eruption there would be a gradual increase of acidity towards the centre, since the outer and more quickly cooling portion would have no time to become differentiated by gravitation. The lower portions would show an increased basicity towards the centre. This is all in cordance with observed facts.—The relation between structural and magneto-optic rotation, by A. W. Wright and D. A. Kreider. Experiments on the crystallisation of various substances in a magnetic field show no indisputable evidence of the influence of the field upon optically active structure. In the case of sodium chlorate, there seems to be a preponderance of optically active crystals when deposited in a magnetic field, but these are right-handed or left-handed in about equal proportions.

Wiedemann's Annalen der Physik und Chemie, No. 11.—Electric dispersion in organic acids, esters, and glass, by K. F. Löwe. Drude's rule, that anomalous electric dispersion is always

accompanied by anomalous absorption, receives a negative confirmation in the esters of the fatty acids and benzoic acid, which show neither. Other esters and alcohols show a rough approximation to Drude's formula. In the glasses, the relation between absorption and dispersion is undefined.—Limits of the solid state, by G. Tammann. Ostwald considers it possible that the transition from the liquid to the crystallised state takes place continuously along a Thomson-van-der-Waals isothermal. The author shows that this assumption implies the possibility of four volumes at the same pressure, and that the liquid isothermals may be followed up beyond the point of intersection with the crystal isothermals. This eliminates what Ostwald calls the meta-stable phase of crystallisation.—Contact electricity between metals and liquids, by A. Heydweiller. The author introduced minutely sub-divided metals into a narrow tube containing an electrolyte, and passed a current through the latter. Any contact electrification was then indicated by motion of the particles. He thus tested Coehn's rule, according to which bodies with a higher dielectric constant are positively charged by contact with bodies of a lower dielectric constant. Platinum, gold, tin, and other metals, immersed in various mixtures of water, chloroform, and acetone, show an agreement with Coehn's rule, but not when immersed in alcohol.—Use of a vacuum tube for thermal insulation, by A. Weinhold. In connection with d'Arsonval's claim of having employed the principle of Dewar's double bottle in 1887, the author mentions that he described the same apparatus as long ago as 1881, in the first edition of his "Physikalische Demonstrationen."

THE current number of the *Izvestia* of the East Siberian branch of the Russian Geographical Society contains several valuable papers.—M. Prein gives a list of 424 phanerogam plants collected in the west of the northern parts of Lake Baikal, and his list contains several species which are new for this interesting region.—A paper by S. V. Yastremski, on the ancient beliefs of the Yakutes (who belong to the Turkish stem), not only shows that their religion has a good deal in common with the religion of the Mongols, but also reveals traces of a worship of good-willing deities, which worship was practised by so-called "*white shamans*" (the *shaman* is the witch-priest). Traces of this worship, which has been intermingled in recent times with Christianity, are now found in epical poetry and popular songs only, but "white shamans" were known to exist not further than ten years ago. At the present time the "black shamans," or worshippers and conjurers of the bad-willing deities only, are retained.—M. S. Peretolchin gives an account of his ascent of the Munku-Sardyk peak in the Sayans, and describes a small glacier on its southern slope, surrounded by old moraines testifying to its former greater extension. Phanerogams were found up to an altitude of 10,230 feet.—N. A. Witaszewski gives interesting copies of inscriptions on the crags of the Olekma.—All papers are summed up in German.

IN the *Journal of Botany* for November and December, Col. H. W. Feilden continues and concludes his list of the "Flowering Plants of Novaya Zemlya," &c., 195 species in all, besides four Vascular Cryptogams.—Mr. E. S. Salmon describes and figures a moss new to the British flora, *Catharinea tenella*, lately found in Kent.—Messrs. H. and J. Groves describe and figure another very interesting addition to the British Cryptogamic flora, *Nitella hyalina*, discovered in Cornwall, one of the most beautiful of the Characeæ, distinguished from other species of the genus by the presence of secondary branchlets.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 24.—"On the Condensation Nuclei produced in Gases by the Action of Röntgen Rays, Uranium Rays, Ultra-violet Light, and other Agents." By C. T. R. Wilson.

By means of expansion experiments the degree of supersaturation necessary to cause water to condense on nuclei from various sources was determined. The nuclei produced in air or hydrogen by Röntgen rays or Uranium rays, or by the discharge of electricity from a pointed platinum wire, or by the escape of negative electricity from a zinc plate exposed to ultra-violet light, all require the same expansion (v_2/v_1 = 1·25, corresponding to a fourfold supersaturation) in order that water may condense on them. In moist air or oxygen exposed to ultra-violet light, nuclei are produced throughout the volume of the gas exposed to the rays; when the radiation is weak, these require as great a degree of supersaturation as the various nuclei above mentioned in order that water may condense on them; but with stronger radiation they appear to grow, and the expansion required to make water condense on them then depends on the intensity of the ultra-violet light, and on the time for which the gas has been exposed to the rays before expansion. With very strong ultra-violet light the growth of the nuclei continues even in unsaturated air till they become visible as a fog. Sunlight produces in air nuclei resembling those produced by weak ultra-violet light. Certain metals in contact with moist air produce nuclei always requiring great supersaturation in order that water may condense on them. This effect is most strongly exhibited by amalgamated zinc, with which comparatively dense fogs may be obtained on expansion.

It was found that the nuclei produced by X-rays or Uranium rays may readily be removed by applying an electric field, showing that the nuclei are identical with the ions to which the conducting power of the gas when exposed to the rays is due. Similar experiments with the nuclei produced by the action of ultra-violet light on moist air, and with those resulting from the presence of metals, showed that such nuclei do not move in an electric field. This is in agreement with the absence of conducting power.

Royal Microscopical Society, November 16.—Mr. E. M. Nelson, President, in the chair.—The President read a paper describing a very large and elaborate binocular microscope possessing many original features; it was designed and made some years ago by a friend. The description was illustrated by an excellent photograph of the instrument shown upon the screen.—Mr. Beck exhibited two slides of *Amphipleura pellucida*, mounted by Prof. Hamilton Smith in his high refractive medium; they were shown under $\frac{1}{12}$ achromatic oil immersion objectives of N.A. 1·0, and 1·25, the diatoms under the former showing re-solution very fairly, bur those under the latter were re-solved most satisfactorily.—Mr. Michael called attention to the slides of diatoms mounted in high refractive media, which Mr. Curties had brought for exhibition.—Dr. Hebb said there was a paper contributed by Mr. A. W. Waters, "on Bryozoa from Madeira," of which he gave a short *résumé*. Mr. Michael remarked that a systematic paper such as this would prove of considerable value to those who were studying the subject. Mr. Waters was at the present moment the best English authority on the Bryozoa, and their knowledge of these organisms had been systematised and made available largely by his contributions to the subject and by his skill as a draughtsman.

Mathematical Society, December 8.—Lieut.-Colonel Cunningham, R.E., Vice-President, in the chair.—Major Macmahon, R.A., F.R.S., communicated a discovery he had recently made in the theory of compound partitions.—Mr. J. E. Campbell read a paper on simultaneous partial differential equations.—The following papers were communicated in abstract: On hyperplane coordinates, by W. H. Young.—On a theorem allied to Laplace's, by Prof. W. H. Metzler.—Two problems of wave propagation at the surface of an elastic solid, by T. J. Bromwich. The two problems deal with the velocity of propagation of waves in hypothetical elastic solids. An attempt is made to find causes for the discrepancy between the observed velocities of earthquakes and those calculated by theory. The first case considered is that of a thin elastic shell (this case appears to have been solved by Lord Rayleigh, but it has not apparently been thought worthy of publication by him). The author finds that, with the elastic constants given by Prof. Milne as representing the nature of rocks at the surface of the earth, the deduced velocity has a value agreeing much more nearly with observed velocities than the velocity deduced from Lord Rayleigh's paper in the *Proceedings* (vol. xvii.). The second problem solves the hypothetical case of a thin skin fastened to the surface of a solid, the elastic constants of the two materials being supposed different. As might be expected the effect of the skin is not large, and the result only indicates that it is necessary to know the elastic constants at a depth comparable with a wave-length, before we can get a satisfactory comparison between theory and observation. Also by the same author, the influence of gravity on waves in an elastic solid, with especial

ference to the earth. The paper contains solutions of three problems which are concerned with the effect of gravity on the velocity of propagation of elastic waves in the earth. The first and second are based on a paper of Lord Rayleigh's (*Proceedings*, vol. xvii.). They show that when the wave-length is short enough for us to consider the earth as bounded by an infinite plane, the effect of gravity must be small. The third deals with the vibrations of an elastic sphere under its own gravity; here the modification appears to be considerable, when we consider the approximate elastic constants of the earth. This case is partly founded upon a paper by Prof. Lamb (*Proceedings*, vol. xiii.) on the vibrations of a sphere. The author finds that the effect of gravity is necessarily null when the order of the harmonic disturbance is zero or unity. For a sphere of the mass, size and gravity of the earth, but with rigidity about that of steel, he finds the gravest free period to be 55 minutes; without gravity the corresponding free period is 66 minutes. If the rigidity is about that of glass, the period is 78 minutes; without gravity, 120 minutes. The solids throughout are supposed to be incompressible in order to avoid the difficulties introduced by gravity. —Lieut.-Colonel Cunningham (Mr. Tucker, *pro tem.*, in the chair) drew attention to the three following exceptionally high numbers:—

$$N_1, N_2 = [2^{213}.(2^{209} \pm 1)^3 \mp (2^{211} \pm 1)^3] = (2^{210} \pm 1)(2^{210} \mp 1)^3$$
$$N_3 = [\{(2^{105} + 1)^4 - 2^{108}.(3.2^{104} + 1)\}^2 + \{(2^{105} + 1)^4 - 2^{212}.(2^{106} + 3)\}^2] = 2.(2^{210} + 1)^4.$$

The *complete factorisation* of the numbers $(2^{210} \pm 1)$ being known (see Lucas's memoir "Sur la Série récurrente de Fermat," Rome, 1879, pp. 9, 10), the three large numbers (N) are also *completely factorisable into their prime factors.* The two N_1, N_2 are of order 2^{840}, and therefore contain 253 figures; whilst N_3 is of order 2^{841}, and therefore contains 254 figures. The largest number hitherto *completely factorised* into its prime factors (so far as known to the author) is $(2^{210} + 1)$, which contains 64 figures.

Geological Society, December 7.—W. Whitaker, F.R.S., President, in the chair.—The geological structure of the southern Malverns and of the adjacent district to the west, by Prof. T. T. Groom. The structure of the district is explained on the supposition that the rocks represent the western margin of an old mountain-chain overfolded towards the west; the eastern portion of this range lies faulted down and buried beneath the Permian and Mesozoic of the vale of Gloucester. All the characteristics of a folded chain are present, namely, the profound folds, overfolds, thrust-planes, and transverse faults; and a typical Austönungs-zone is seen to the west.—The Permian conglomerates of the Lower Severn basin, by W. Wickham King. The rocks thus described are the calcareous conglomerates included in the Middle Permian of the Shropshire type, and exposed north of the Abberley and Lickey Hills. Three calcareous horizons occur, interstratified in sandstones or marls, and surmounted by the Permian breccia. It was the opinion of Ramsay and others that the materials of the calcareous horizons and of the Permian breccia had been brought from the Welsh border; but Buckland and Jukes, among others, claimed a southern derivation for those of the Permian breccia, from local hill-ranges to the south. The latter view accords with the fact that the pebbles composing these calcareous horizons, and also the broken fragments constituting the Permian breccias north of the Abberley and Lickey Hills, are coarser in the south-easterly direction, and gradually become finer to the north-west. The fragments embedded in the Middle Permian calcareous bands near the Lickey are chiefly of Archæan rocks; but in all the other districts described there are very few rock-fragments older than Woolhope Limestone. On the other hand, pebbles of dolomitic Wenlock and Carboniferous Limestones are abundant, while Aymestry Limestone, Old Red, Carboniferous, and Lower Permian sandstones occur in greater or less abundance; and all these rocks, except the Carboniferous Limestone, may be seen *in situ* near at hand to the south.

Entomological Society, December 7.—Mr. R. Trimen, F.R.S., President, in the chair.—Mr. McLachlan exhibited a series of specimens of the neuropterous genus *Tetracanthagyna*, de Selys, including a pair of a new species from Borneo, which was the largest known of all recent dragon-flies, though it was slightly exceeded in wing-area by the much more slender *Megaloprepus caenulatus*, a common Central-American species. —Mr. A. H. Jones showed about sixty species of Lepidoptera, taken round electric lights at Zermatt in August.—Dr. Dixey exhibited a series of Pierid butterflies from the Neotropical region to show the existence among them of seasonal forms. The President observed that the exhibit was of special interest, as affording the first recorded evidence of the existence of seasonal dimorphism in Neotropical butterflies.—Mr. G. T. Porritt exhibited an extraordinary variety of *Bombyx quercus*, bred in June last by Mr. W. Tunstall, from a larva found near Huddersfield. The specimen was a female of deep chocolate colour, with the band very faintly traced in dark olive.—Dr. Chapman, Mr. Lloyd, and Mr. Nicholson exhibited butterflies taken by them in Norway from June 20 to July 22, during the past summer at latitudes 60° 12′ and 69° 50′.—Papers were contributed by Mr. R. McLachlan, entitled "Considerations on the genus *Tetracanthagyna*"; by Mr. M. Burr, entitled "A List of Rumanian Orthoptera"; and by Mr. J. H. Leech, on "Lepidoptera Heterocera from China, Japan and Corea."

Zoological Society, December 13.—Prof. G. B. Howes, F.R.S., Vice-President, in the chair.—A communication was read from Mr. H. H. Brindley, on certain characters of the reproduced appendages in the Arthropoda, particularly in the Blattidæ. It was a continuation of a paper published in the *Proceedings* of the Society for 1897 (p. 903), and contained observations on the process of regeneration of the legs in the Blattidæ.—Mr. W. P. Pycraft read the second part of his contributions to the osteology of birds, which dealt with the Penguins (Impennes). The author found it necessary to divide this order into six genera. Of these *Eudyptula* appeared to represent the least specialised form of the whole group, and probably came nearest to the ancestral stock. The Impennes, as a whole, appeared to be most nearly related to the Tubinares. It did not seem possible to distinguish the skeleton of *Catarractes pachyrhynchus* from that of *C. chrysocome.*—One of the most important features of this paper related to the "secto-pterygoid," which the author described at some length. —Mr. W. L. H. Duckworth read a note, illustrated with lantern slides, on a specimen of a female anthropoid Ape which had been received from the Gaboon early in the present year, and as to which he was unable to decide whether it was a Gorilla or a Chimpanzee.—Mr. J. Stanley Gardiner read a report on the Turbinolid and Oculinoid Corals collected during his recent expedition to the South Pacific. Nine species were treated of in the paper, of which four were described as new. —Mr. L. A. Borradaile read the third instalment of a paper on Crustaceans from the South Pacific.—Dr. G. H. Fowler contributed the seventh of a series of papers on our knowledge of the Plankton of the Faeroe Channel. It dealt with the Station-data of depth, temperature, &c., of the hauls of H.M.S. *Research* in 1896 and 1897, with the chief Protozoa and Medusæ of the collections.

EDINBURGH.

Royal Society, December 5.—The Rev. Prof. Flint in the chair.—The Chairman gave a short opening statement, referring, amongst other things, to the Antarctic Expedition, to the survey of Christmas Island, to the new expedition to Socotra, and to Dr. Traquair's important memoir of the preceding session, and concluding with short biographical notices of recently deceased Fellows.—Prof. Kuenen, in a paper on the miscibility of liquids at different temperatures, pointed out the necessity of taking the vapour into account in the discussion of any case of equilibrium. The mixtures dealt with were chiefly mixtures of hydrocarbons and alcohols. In the case of ethane and ethyl alcohol, the solubility curve was shaped like a perverted S—the vapour and upper liquid line joining at the higher temperature, the two liquid lines joining at the lower temperature. A few degrees above the lower temperature at which the two liquids began to exist in equilibrium, it was possible, by moderate increase of pressure, to get the liquids to mix completely again. On the other hand, above the higher temperature at which phenol and water began to mix in all proportions, a large increase of pressure caused a separation of the liquids.—Prof. Ewart, in a paper on reversion in birds and mammals, discussed many instances of reversion either to a recent ancestor or to a remote ancestor. The influence of inbreeding as establishing prepotency in one or both of the parents was clearly shown, a prepotent parent or ancestor preventing reversion. Prof. Ewart illustrated his remarks by means of living specimens of pigeons and rabbits, and threw on the screen views of the zebra hybrids with which he had been experiment-

ing for some time. These hybrids showed markings much more like the markings of the Somali zebra than of their Burchell sire; they seemed to be a case of reversion to a very remote ancestor.

Paris.

Academy of Sciences, December 12.—M. Wolf in the chair.—Physical study of the elasticity acquired by muscular tissue in a state of physiological work, by M. A. Chauveau. The experiments cited were all carried out upon the flexor muscles of the fore arm of man, and were so arranged as to eliminate the disturbing influence of the weight of the limb. The elongations in the length of the muscle produced by a given increase of load are compared with the elongations which would be produced in inert substances, and the conclusion is drawn that the law obeyed by the muscle is given by $e = p(1 + r)$, where e is the increase or decrease of the force of elasticity which is maintained in a muscle put in statical contraction, p is the charge sustained, and r the muscular contraction.—Influence of metallic armatures upon the properties of mortars, by M. Considère. The use of iron or steel for the interior armature of mortars, although opposed by military engineers, on account of the results of tests made by tension only, is justified by the results of the experiments given.—Observations of the Brooks Comet (October 1898), made at the Observatory of Algiers with the 31·8 cm. equatorial, by MM. Rambaud and Sy.—Observations of the planet DQ (Witt) and the Perrine-Chofardet and Chase comets, made at the Observatory of Toulouse with the Brunner equatorial, by M. Rossard.—Observations, made at Athens, of the Leonid and Bielid swarms, by M. D. Eginitis.—On the examination of the singularities of a function defined by a Taylor's series, by M. Émile Borel.—On systems of partial differential equations reducible to ordinary differential equations, by M. Jules Beudon.—On the determination of the group of numerical equations, by M. Edmond Maillet.—On lines composed of rectilinear parts, by M. D. Gravé.—On the practical synchronising of regulators, by M. L. Lecornu.—On the ratio of the two specific heats of gases, by M. Louis Boltzmann. Remarks on a paper on the same subject by M. Leduc, with especial reference to the ratio found for the new atmospheric gases. The author arrives at the conclusions that the molecule of a perfect gas for which $k = 1\frac{2}{3}$ ought to behave in molecular concussions as a rigid sphere, a condition which is probably only possible for monatomic gases: in a gas for which $k = 1·4$, over an extended range of temperature, the molecule behaves like two spheres rigidly joined together, a case probable for diatomic gases only. At high temperatures, even perfect gases ought to show a diminution of k. For polyatomic gases this would be evident at ordinary temperatures.—On a curious phenomenon of adherence of metallic filings under the action of the electric current, by M. Thomas Tommasina.—On the arc with alternating currents, by M. A. Blondel.—On the transformation of the carbonate of orthocresol into a homologue of the phthalein of orthocresol, by M. P. Cazeneuve. The phthalein is produced by the action of soda lime upon the carbonate.—On the mixed phenyl-ethyl phosphates, by M. Albert Morel.—Chlorination of benzene in presence of aluminium chloride, by MM. A. Mouneyrat and Ch. Pouret. If $AlCl_3$ is present in the proportion of 30 gr. to 1000 gr. of benzene, the latter absorbs a rapid current of chlorine completely at 50 C. Fractional distillation of the product gave 760 gr. of pure C_6H_5Cl, together with 450 gr. of dichlorbenzenes. The latter can be obtained readily in quantity by similarly chlorinating monochlorbenzene, the para compound predominating.—Action of oxidising agents upon some nitrogen compounds, by M. Œchsner de Coninck. A study of the reaction between chromic acid and potassium bichromate and numerous nitrogen compounds, including hydroxylamine, hydrazines, ureas, and amides.—Action of the bacillus *Coli communis* and the Eberth bacillus upon nitrates, by M. L. Grimbert. The nitrogen evolved by the action of these bacilli upon a nitrated medium, is always at least double that corresponding to the nitrate taken; hence the nitrogen evolved cannot arise exclusively from the nitrates, but must come in part from the amido-compounds always present in the culture.—The assimilation of nitric nitrogen and of ammoniacal nitrogen by the higher plants, by M. Mazé. Details of experiments are given which confirm the conclusions of M. Müntz, that ammonia, as such, can be absorbed and assimilated by plants.—On the natural dissemination of wine yeasts, by M. Léon Boutroux. Remarks on a paper by M. J. A. Cordier. In opposition to the latter, the author holds that the theory of dissemination by insects is more in accord with facts than the theory of air dissemination.—The juice of fungi as a vaccine against snake poison, by M. C. Phisalix.—The endomorphic modifications of the gabbro of Pallet (Loire-Inférieure), by M. A. Lacroix.—On the part played by subterranean deposition in the constitution of the soil of a portion of the department of Orne, by M. Stanislas Meunier.

BOOKS and SERIALS RECEIVED.

Books.—The Gold-Fields of Australasia: K. Schmeisser and K. Vogelsang, translated by Prof. H. Louis (Macmillan).—The Micro-organism of Faulty Rum: V. H. and L. J. Veley (Frowde).—Twenty-seventh Annual Report of the Local Government Board: Supplement containing the Report of the Medical Officer for 1897–98 (London).—Annuaire de l'Observatoire Municipal de Paris, 1899 (Paris, Gauthier-Villars).—Les Recettes du Distillateur: E. Fierz (Paris, Gauthier-Villars).—Ostwald's Klassiker der Exakten Wissenschaften, Nr. 97 to 100 (Leipzig, Engelmann).—Congrès National d'Hygiène et de Climatologie Médicale de la Belgique et de Congo, première partie. Belgique (Bruxelles, Hayez).—Recent Advances in Astronomy: Dr. A. H. Fison (Blackie).—University College, London, Calendar for Session 1898–9 (Taylor).

Serials.—Engineering Magazine, December (222 Strand).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, 1898, Nos. 9 and 10 (Bruxelles).—Observatory, December, and Companion (Taylor).—National Geographic Magazine, November (Washington).—Notes from the Leyden Museum, April and January (Leiden).—Atlantic Monthly, December (Gay).—Journal of the Anthropological Institute, August and November (Paul).—Journal of the Marine Biological Association, November (Plymouth).—An Account of the Crustacea of Norway, Vol. 2, Parts xi., xii. (Bergen).—American Journal of Science December (New Haven).—Morphologisches Jahrbuch, 26 Band, 3 and 4 Heft (Leipzig).—Quarterly Journal of Microscopical Science, November (Churchill).—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. 42, Part 5 (Manchester).

CONTENTS.

THURSDAY, DECEMBER 29, 1898.

HE GOLD COAST OF WESTERN AFRICA.

ne Years on the Gold Coast. By the Rev. Dennis Kemp, late General Superintendent Wesleyan Missions, Gold Coast District. Pp. xv + 279. (London: Macmillan and Co., Ltd., 1898.)

he Gold Coast, Past and Present. By George Macdonald, late H.M. Director of Education for the Gold Coast Colony and Protectorate, &c. Pp. ix + 352. (London: Longmans, Green, and Co., 1898.)

THE Gold Coast of West Africa and the Loango Coast of South-west Africa are regions of especial interest the ethnologist, for in these he is not, as he is in the ajority of African regions, dependent on such fragments information as he can gather from books written by avellers, who, to him, seem deliberately, malignly deter-ined to give as little of the sort of information an hnologist wants as possible; and only too frequently ve that little in a manner that arouses suspicion in the ind of a cautious student.

However on the Gold Coast and the Loango Coast the hnologist is not dependent on the traveller, having at his ommand a mass of information: concerning the first, in e works of seventeenth century writers, grandly supple-ented in this century by those of Sir A. B. Ellis, Reindorf, uchholtz and others; and concerning the second, in the orks of the Roman Catholic missioners, who for some oo years (1490–1670) held that region, and in this century hese have been supplemented by the works of Adolf astian. Bastian, be it granted, is a jungle of information, acking the brilliant lucidity of Ellis, and he has led many stray, from neither they, nor he, knowing that the fetish f the Loangoes and of the whole of the Fiot tribes is a chool of fetish differing very markedly from other chools, and particularly from that of the tribes Ellis ealt with. Nevertheless, Bastian's work is monumental nd exact.

The two books dealing with the Gold Coast that are ow before us, in addition to dealing with an interesting egion, are especially valuable in being not the works of ravellers spending busy, hurried, worried sojourns in the ountry, but of men resident there for considerable eriods, and of a class thrown by their occupations into ontact with the natives in ways which compel the cquisition of detailed knowledge concerning them.

We will take "Nine Years at the Gold Coast" first, oth on account of its exceptional charm, and of its being he longest record of experience there which has been published since Cruickshank's great book.

All who know West Africa know that the Rev. Dennis Kemp is one of the great African missionaries, the man who by the power of his personality and his skill in organisation has made the Wesleyan Mission at the Gold Coast one of the most thriving and successful missions in Africa. It is necessary to mention this, because you get no hint of the fact directly from Mr. Kemp. The writer, a person who has, more than most men, come under adverse criticism from Mr. Kemp, well remembers his stating at the end of a warm argument, that he believed in three things—the Christian religion, the British constitution, and Mrs. Kemp, and this he displays amply in his book. At the same time, however, he displays quite unconsciously those qualities which have enabled him to do so much good service—a perfectly honest, simple, manly spirit; militant, but suffused with an abiding chivalry. This latter quality, indeed, he displays almost too much, particularly when it comes to the representatives of other missions. Any one acquainted with the state of affairs between the Roman Catholics and the Wesleyans on the Gold Coast, might have reasonably expected that at least the former mission would not receive a kindly reference; but, no, the Rev. Dennis Kemp arrives there by praising the nuns.

It must not, however, be surmised that Mr. Kemp is so uniformly benign as to be uninteresting to the un-regenerate reader; far from it. He says some exceedingly harsh things about white traders and natives; but he also gives us, so frankly, many stories of native honour and kindly helpfulness, that they almost take the sting out of his general remarks on the character of the African. He says also:

"I do not remember meeting with a merchant who was altogether regardless of the welfare of the natives. I have met with many who have taken the deepest interest in their advancement."

So we may conjecture that even traders are not hopelessly bad in Mr. Kemp's eyes.

Mr. Kemp's criticism on native character is interesting, but we venture to think that on the whole it is too severe. Cowardice, theft, and lying, are certainly not its most prominent characteristics; but it must be remembered that the people of whom he is writing, the Tshi and Gâ speaking peoples, are people who have been subjected to the disintegrating effects of alien culture. To the north they have been played on by the Muhammedanised Berbers of the Western Sudan; to the south by Europeans of divers kinds. That after some 400 years of this sort of thing the Gold Coast native should be as good as he is, is a thing highly to his credit, and that he also preserves a quantity of excellent fetish is a subject of congratulation to the ethnologist.

The main interest of the book to us here is the amount of fetish information which it gives. Of course it does not give one-quarter as much as it might; for example, Mr. Kemp frequently mentions, with pleasure, the conversion of a fetish priest, and adds that these men confess their past impositions; but Mr. Kemp keeps those confessions to himself in an irritating manner. Still there is much highly interesting information given, and although "Nine Years at the Gold Coast" is naturally written from a missionary standpoint, this does not detract from its value, for never for one moment does Mr. Kemp's point of view lead him to telling half-truths; when he once mentions an incident, you have it whole with all its instructive, pathetic and amusing atmosphere. Never for one moment does he fail in his belief in the efficacy of mission work; never for one moment is he pessimistic about it, or anything else, though he will tell you things about the mission convert that a more nervous man would omit. Here, for example, is a delightful story.

"The account of a palaver between two Christians which is not given in the Annual Report, but it is furnished by the superintendent who assisted at the settlement of the matter. Vendors in the market-place are for the most part representatives of the gentler sex. It sometimes happens that two, or more, will engage in hot dispute. Their angry voices may be heard above the din of a thousand of their sex peacefully engaged in lawful trade. There was an occasion when, as at Philippi, Sisters Euodias and Syntyche were not 'of the same mind.' 'Softly, softly,' said one to the other, 'we are Christians; let us go to the minister.' To the minister they went. The elders of the church were summoned, and then for a time superfluous steam was allowed to escape in yells, shrieks, and frantic gesticulations. Care was taken that the disputants were separated by at least a table or a desk, so as to prevent the one doing bodily harm to the other. In a few moments comparative order was restored, the whole case stated, the opinions of the elders expressed, and the outside world knew nothing of what had occurred."

That this was a great improvement on the ordinary market-place row, there is no doubt; and the vision of the active elders interposing desks and tables between the ladies is very pleasing. Most cordially also do we recommend the account given by a colleague of Mr. Kemp's, of his experiences when taking over a district to all those who think missionaries lead a life of luxurious calm.

"The house had been deserted for some time. The white ants had attacked the floor, and dry rot had set in. When I put my foot on the floor, it went below; as also did three of the legs of the chair in which I attempted to sit. The roof served little purpose but for the study of astronomy. The house swarmed with mosquitoes, and the 'kotokrodu' in legions had taken up their abode in the missionary's bed-chamber. There were myriads of black ants conveying mud from my walls to make themselves a home in my room. On sweeping the floor by means of a plank placed crosswise, I removed buckets full of refuse, and in doing so disturbed swarms of beetles, many as big as miniature clock-weights. There were rats galore, and one snake. There was a vampire, which I succeeded in securing; it measured twelve inches by two. . . . Night came on, but it was made hideous by the unearthly yells of a pair of jackals. Dropping upon an old bed, which had seen no linen for a long time, I gathered the mosquito curtain around and essayed to sleep. But I had made my calculation without reckoning with the buzz of mosquitoes and the visits of rats. I had thought that the bed was for my use, but a mother of the rodent tribe and her family were there to dispute the point with me. As, however, might and right prevailed, my visitors took their revenge on my under-clothing, and left by the morning little but buttons, and, as the Irishman says, a bundle of holes stitched together."

Mr. Kemp's book also contains an interesting description of the Ashantee country and of many journeys made into the bush, and to the many towns of the Gold Coast, and it abounds with anecdotes of personal experience. All these together go to give us a vivid picture of life in that region, making the book at once interesting to those who need not go there, and highly useful to those who must.

The main interest of the remarks Mr. Kemp makes on fetish, lies in his bringing forward so prominently the influence of coincidence in supporting the belief in it. The series of stories and the accounts of charms given in the pages 100–133 bring this point out very clearly, and are well worthy of study. And although Mr. Kemp's definition of fetishism is not what one could call sympathetic, in the main it is exceedingly accurate.

"Unlike the religions of other heathen countries, fetishism is represented by very few idols. It is a most unusual thing to see a pagan adoring a block of wood or stone. No heathen temples adorn the land, no elaborate ritual accompanies the ceremonies, no sacred writings are found in which the traditional beliefs of the ancients might be expressed. The religion, which is one of the lowest forms in existence, consists mainly of superstitious beliefs—largely aided by witchcraft—which have been handed down from generation to generation by a succession of priests, who delude the credulous minds of the people by their fraudulent practices. Fetishism is essentially spirit-worship, but of so debasing and demoralising a type as to be hardly distinguishable from devil-worship. As stated in an earlier chapter, the heathens certainly acknowledge their belief in a Supreme Being, the Creator of all things, with Whom, however, it is quite impossible to hold any communication. They live in constant dread of subordinate deities, who are always prepared to visit with wrath the individual or nation at large. The residences of these beings are known as fetish."

This last statement is so correct, at any rate for West and South-west Africa, that the student of this great nature religion called fetishism should constantly bear it in mind, as it will save him from the errors that have arisen from customary use of this word.

The beautiful series of illustrations in this book also add greatly to its interest and value; and we sincerely hope before long Mr. Kemp may be induced to give us further information, particularly those confessions of the converted fetish priests.

We have not left sufficient space to do justice to Mr. MacDonald's book. It is, with the exception of having no index, a most excellent and careful arrangement of material, that in its scattered state is available only to those who have time and opportunity to work in libraries. Mr. MacDonald has devoted much time and care to placing this material at the service of people, who though not having ready access to libraries yet are in touch with the affairs to which authorities like Ellis, Bosman, and Reindorf refer. In addition to doing this, Mr. MacDonald gives an immense amount of thoroughly useful and practical local information, thereby making this book of his a thing no one dealing with the Gold Coast can dispense with. We wish he had given us more personal comment on affairs there; but the fact of his position and long residence on the Gold Coast makes us take what he chooses to quote without comment from other writers as things proved to be true by his experience. We should like to point out his statement on p. 4, where he says the Ivory Coast is "now known as French Guinea." This is not the case entirely. In 1890 the French possessions in West Africa were, for administrative purposes, divided into Senegal, the French Sudan, French Guinea with Dahomey. But the term French Guinea is customarily restricted to the Fouta Djallon region, and the region Mr. MacDonald refers to is still known as the Côte d'Ivoire. Mr. MacDonald's observations on the Kru tribes are also slightly misleading. It is a matter of regret that so many white men, with so many opportunities of studying these interesting tribes, do not do so; confining themselves to

superficial observation and stereotyped opinion. Certainly we should have hesitated to say:

"Of all the African tribes belonging to the West Coast, the Kru boy lends himself most readily to imitation of the European."

The resistance of these tribes to alien culture being exceedingly marked. Be it granted the Kru man will acquire all the European clothes he can while he is away on his term of service; the influence these things have on him is, as Dr. Wrenchen would say, "merely external," and the secret of his going ashore at "we country" on his return there, got up in the extraordinary costume he does, lies in his relations not being able to appropriate his personal property; his general property, the things he cannot wear, are their prey. The State organisation of the Kru tribes is a subject of especial interest. In all West African tribes the tendency of property to become family instead of individual is strongly marked; but, owing to the isolation the Krus have enjoyed in their own country, it is to be found in its most marked state amongst them. Mr. MacDonald also repeats the customary accusation against them of cowardice; but in this connection it should be remembered, firstly, that the Kru men met down the Coast away from their homes, as labourers and canoe-men, are of the class called by them *Kedibo*. They are the young men of the communities; they have in their own country little influence, or power, until they have amassed enough wealth to rise to the grade of the fighting-men, the *Sedibo* class, and when they do this they usually remain at home in "we country"; and the courage of the *Kediboes*, even as Mr. MacDonald, indeed, states, when it comes to surf work, is undoubted. Secondly, it must be remembered that all African fetish worshippers are apt to dislike being killed in any way far away from home; at home they do not so much object. The explanation is simple. Away in an alien land their funeral rites cannot be properly carried out, and therefore they stand the chance not only of losing their lives, but their souls into the bargain. We only mention this matter, however, in order to induce so able an observer as Mr. MacDonald to bring his attention to bear on the interesting subject of the Kru tribes, for information regarding them is of high ethnological importance. M. H. K.

A HERPETOLOGY OF EGYPT.

Zoology of Egypt: Volume First, Reptilia and Batrachia. By John Anderson, M.D., LL.D., F.R.S. Pp. lxv + 371; 59 pls. (London: Quaritch, 1898.)

WHEN, some six years ago, Dr. Anderson undertook the investigation which has resulted in the noble work now published, our knowledge of the herpetological fauna of Egypt was very meagre indeed, and could not compare with that of the neighbouring countries such as Tunisia, Algeria, and Syria. A list of the reptiles and batrachians of Egypt showed an imposing array of species, many of which now prove to be merely nominal, but these were represented in museums by a small number of specimens, few of which bore indications of exact localities. In fact, such material as then existed was quite inadequate for a study of the distribution as required by modern zoology, and the most important subject of variations and delimitation of species could not be attacked.

The author's first task was therefore the bringing together of a large number of specimens, from as many parts of the country as possible, and this was carried out by him with extraordinary energy during successive visits to Egypt in the winters 1892 to 1895, his personal investigations extending even to Suakim, beyond the limits of Egypt proper. Not only did Dr. Anderson himself and with the help of natives succeed in collecting a very large series of specimens, many of which were brought home alive and could be sketched in natural colours and attitudes, but he was also fortunate enough to enlist the co-operation of many residents and visitors interested in natural history matters; the result being the splendid collection the bulk of which has been presented to the British Museum, a second, nearly complete set having been reserved for the Museum of the Egyptian Government School of Medicine at Cairo.

The work comprises not merely an account of all the reptiles and batrachians of Egypt proper, but also includes those that are known to occur on both sides of the Nile as far south as Wadi Halfa, to which the species met with in the district of Suakim, on the littoral of the Red Sea, are added. The few species that have been accorded from the Nile Valley as far south as Khartum, Kordofan, and Sennaar, are incidentally noticed.

Egypt forms part of a zoological sub-region, extending from the western confines of the Sahara to the desert tracts of North-western India, combining features of the two regions to which it is transitional, viz. the Palæarctic and the Æthiopian, with an endemic element specially adapted to desert-life. One of its striking features is its poverty in batrachians, the valley of the Nile from Khartum to the Delta possessing only three species of the tailless order, one of which has a wide distribution in Europe and Asia, the two others being found over nearly the whole of Africa south of the Sahara. Tailed batrachians, represented in the British Museum by some undetermined Salamandrine larvæ stated to have been collected at Ramleh, near Alexandria, have escaped Dr. Anderson's diligent search in the Mediterranean littoral. The reptiles are represented, within the geographical limits adopted in this work, by one crocodile, two chelonians, forty-two lizards, three chameleons, and twenty-eight snakes, numbers not above those of previous estimates, the additions made by the author being counterbalanced by the relegation to synonymy or the degradation to varietal rank of many a form looked upon by previous herpetologists as a species.

Of the two categories of systematists suggestively if inelegantly designated as "lumpers" and "splitters," Dr. Anderson must unhesitatingly be classed among the former. Although, we think, he occasionally goes a little too far, as when he hints at the possible specific identity of *Chamaeleon calcarifer* and *Ch. calyptratus*, *Acanthodactylus savignyi* and *A. pardalis*, *Echis carinatus* and *E. coloratus*, his treatment of the difficult subject of species commends itself to the philosophical naturalist as affording a much clearer insight into the problems of distribution and variation than could be obtained with the opposite system so much in vogue at

the present day. As examples we would point especially to his masterly accounts of *Ptyodactylus hasselquistii* and *Chalcides ocellatus*, which may be recommended for study to any who should still doubt the derivation of what are called species, or who, unable to devote themselves to original investigation of this kind, and influenced by statements of ignorant or prejudiced writers, persist in looking upon species as definite units in nature. In these examples we see how forms that are so different in their extremes, in size, scaling, and coloration combined, that one would unreservedly refer them to distinct species, are connected by such insensible gradations that it is with the greatest difficulty, and only by drawing arbitrary limits, that we are able to break up the series into a number of varieties; and how these chains of varieties correspond with the direction of definite lines of geographical distribution. In order to render the degree of individual variations more readily intelligible, long lists of measurements and tabulations of details of lepidosis are appended; these tables will prove of lasting value, from the care and completeness with which they have been drawn up.

It is only to be regretted that this exhaustive treatment of variations outside the limited range of Egypt has not been carried out through the whole work, as it would have yielded highly interesting results in the case of *Latastia longicaudata*, *Eumeces schneideri*, *Mabuia quinquetaeniata*, *Naia nigricollis*, and *Bufo regularis*. In fact, a little inconsistency in the general plan—some families being characterised whilst others are not—together with the omission of anatomical details which an author so well qualified to deal with these matters might have been expected to furnish, are among the few defects we notice in this admirable work.

The coloured plates, forty in number, mostly the work of Mr. P. J. Smit, equal, if some do not even surpass, the best that have ever been published of a group of animals particularly difficult to depict in life-like attitudes. We would specially commend, as high examples of artistic skill combined with scrupulous attention to details, pls. xiv. (*Uromastix aegyptius*), xxix. (*Chamaeleon vulgaris*), and xxxviii. (*Zamenis diadema*). Numerous black plates and figures in the text, drawn by Messrs. J. Green, Smit, and Groenvold, complete the illustrations, one specimen at least of every species known from the area dealt with being represented.

The introduction, dealing with the physical features of the region, is illustrated by a series of exceedingly beautiful photographs in electrotype, as well as by a map showing all the localities whence the specimens described were obtained.

Appearing at the moment when the whole nation is rejoicing over the re-establishment of Anglo-Egyptian rule beyond the limits of Egypt proper, this first instalment of a work on a fauna too much neglected since the days of the famous French expedition, will be especially welcome. It is therefore to be regretted, in view of the increased interest which will no doubt henceforth be taken in the natural history of Egypt, that the small number of the issue—100 copies only—will render the circulation of the book more limited than it deserves.

G. A. BOULENGER.

A BOOK WITH TWO NAMES.

Quick and Easy Methods of Calculating. A Simple Explanation of the Theory and Use of the Slide-Rule Logarithms, &c. With numerous Examples worked out by Robert Gordon Blaine, M.E., Assoc.M.Inst.C.E. &c. (London: E. and F. N. Spon, Ltd. New York Spon and Chamberlain, 1898.)

THE author makes his title, "Quick and Easy Methods of Calculating"—at least, that is all that is in large print on the title-page; but the binder calls it, on the outside of the book, "The Slide-Rule." The binder is right. The author gives a very short account of some methods of shortened arithmetic, in which he points out that it is unnecessary to work out the results of an observation with very great or unlimited accuracy when the observation itself is subject to well-known possible errors. He might have traced the connection between the desired accuracy of the arithmetic and the probable accuracy of the observation as dependant on its form, but he has not. There is a simple non-algebraical and very clear explanation of logarithms; then the real object of the book, an explanation of the slide-rule, follows. As in all explanations of the slide-rule that are published, however clear and obvious they may be to the user of the slide-rule, there is, of necessity perhaps, such an amount of detail and of rule as to possibly scare any would-be user of this invaluable instrument with the fear that he could not hope to remember it all. The writer of this notice has always felt that this difficulty can only be overcome by half an hour's personal explanation, in which case a book becomes unnecessary; however, for those who cannot meet with this personal assistance, the little book before us is clear, logical and accurate. A great number of examples, mainly derived from the engineering laboratory, are given, which serve both to show the great scope of the slide-rule and as exercises in its use.

By way of criticism, the writer would point out that to find cube roots it is preferable to use the slide inverted to set 1 on C against the cube on A, and find at what part of B and D identical readings face each other. Any reading except 1 can be found twice on A, and three places on B and D can be found for the cube roots of n $10n$ and $100n$. The rule that the writer has always given in order to know where to read is as follows: If the cube has 1 (4, 7, &c.) digits the cube root will be found on D to the left of the left possible setting on A. If it has 2 (5, 8, &c.) digits the cube root will be found on D between the possible settings on A, and if 3 (6, 9, &c.) it will be found on D to the right of the right setting on A. This very simple rule has the advantage of never failing. Unfortunately the rule, as given by the author for the less convenient method with the slide not inverted, does not answer, except by chance, for the example he himself gives to illustrate it; for, according to this rule, $\sqrt[3]{638} = 8{\cdot}6 +$ (as given without the $+$ by the author) or $= 1{\cdot}855$, but this is really $= \sqrt[3]{6{\cdot}38}$.

The writer has always felt that though rules for the number of digits may be worth formulating, they are not worth using or remembering; also that the memory is needlessly taxed by any system of instruction such as is

given in the book under notice, even though the principles are perfectly explained, where every different operation has the necessary setting of the rule explained or expressed by a diagram as a different setting or operation. If once the common rule applying to all logarithmically divided scales, whether of numbers, their powers, or of trigonometrical functions, whether ascending together or some inverted, is made clear, the sixth or slide-rule sense has a chance of being developed, and then there is no occasion to remember rules any more.

The author does not mention even the existence of a P line in some rules, which make calculation with fractional indices, or indeed indices of any magnitude as quick and direct as simple proportion, nor does he refer to Lanchester's radial cursor, which enables the slide-rule to be employed for calculations on heat engines and thermodynamics generally so that any adiabatic has its coordinates numerically presented, and even entropy is simply presented.

The quick and easy methods of calculating title is belied by there being no mention of any arithmometer.

C. V. B.

TECHNICAL BACTERIOLOGY.

Manual of Bacteriological Technique and Special Bacteriology. By Thomas Bowhill, F.R.C.V.S., F.R.P.S. Pp. xii + 284. (Edinburgh: Oliver & Boyd, 1899.)

THE scope of this manual may be gathered from the following brief summary of its contents:—Introduction; classification and morphology of bacteria; methods of sterilisation. Part i. Principles of bacteriological technique. Part ii. The preparation of nutrient media, and methods of cultivating bacteria. Part iii. Special bacteriology. Part iv. Mould fungi. Part v. Yeast fungi. Part vi. Protozoa or animal parasites.

The first eighty-six pages deal with bacteriological technique, and the author is to be congratulated on having placed the subject before his readers in a clear and concise manner, and in such a way as greatly to facilitate reference. Moreover, there is much that is new, or comparatively new, in this portion of the manual: *e.g.* method for inoculating rabbits for the diagnosis of rabies; Bowhill's method of staining flagella and bacteria simultaneously with orcëin; Roth's method of examining butter for tubercle bacilli; Neisser's method for the differential diagnosis of diphtheria bacillus in cover-glass specimens; points to be observed in describing an organism; inoculation of animals (subcutaneous, intravenous, into the lymphatics, into the serous cavities, &c.), observation of animals after inoculation, and post-mortem examination of animals.

The methods of examining air, water and earth are not treated as fully as might be wished. In examining soil, Fraenkel's method only is described. Fraenkel advocates the direct mixture of the soil with the nutrient gelatin. But the number of bacteria per gramme of surface soil is over one million. Hence to obtain separate colonies it is evident that either an almost imponderable fragment of soil must be used, or else an exceedingly large amount of nutrient material. There can be little doubt that the only practical method is to dilute the soil very largely with sterile water, and to make cultivations from the resulting mixture of soil and water.

Elsner's method for separating *B. coli* and *B. typhi abdominalis* is given, but the phenol-gelatin method, which many observers find more useful, is not described in this section of the work. In Part iii., however, reference is made to the method of separating the typhoid bacillus by carbolising the water, and incubating it with an equal part of sterilised peptone-salt solution, and thereafter making Elsner potato-gelatin plate-cultures. No description appears to be given of the method of filtering large quantities of water through a sterile Pasteur filter, brushing the surface of the filter with a sterilised brush into a few cubic centimetres of sterile water, and from the filter brushing suspension of bacteria and water, making *surface* plate-cultures in phenol gelatin.

The terminology adopted as regards the number and arrangement of the flagella of bacteria, which, as the author states, is borrowed from that applied to the Protozoa, is open to some criticism, and is hardly to be recommended.

The second and most important section of this manual deals with Schizomycetes, Blastomycetes, Hyphomycetes, and Protozoa.

It might be anticipated that a veterinary surgeon of Mr. Bowhill's reputation would give an account of some of the diseases caused by micro-organisms which affect the lower animals, and which are either not described at all, or are described in an imperfect manner in the ordinary text-books of bacteriology. Nor is this hope in vain, for the author writes lucidly and with all the authority of an expert about such diseases as swine fever, swine plague, swine erysipelas, pleuro-pneumonia contagiosa bovis, broncho-pneumonia bovis, grouse disease, &c. Moreover, glanders, diphtheria and tuberculosis, as they affect man and animals, are ably dealt with.

It is to be regretted that the author has given no description of *B. enteritidis sporogenes* (Klein), especially when it is considered that the spores of this anærobic micro-organism are found in the excreta of some of the lower animals, and that it appears to be causally related to acute diarrhœa in man. As the author is well up to date in nearly all respects, we hope to find this omission remedied in a future edition. That a new edition will soon be called for need not be doubted, as there is certain to be a large demand for a work of such sterling merit as this one undoubtedly is.

In the concluding portion of the book—Part vi., Protozoa—an excellent account is given of Texas cattle fever, plasmodium malariæ, &c.

We cannot give unstinted praise to the illustrations. Some, indeed, are very good, but many of the photomicrographs are disappointing. However much we may welcome the author's orcëin method of simultaneously staining bacteria and their flagella as an aid to the differential diagnosis of bacteria, we cannot, to judge by the results, regard it as a good method where reproduction is aimed at. The author represents *B. coli communis* as multi-flagellated. The true *B. coli communis* has only one to three flagella.

While we have ventured to indulge in a few possibly adverse criticisms, we are careful to conclude with the

remark, namely, that no student, or even expert, not only in veterinary but also in medical and sanitary science, can afford to be without a copy of this excellent manual.

The type, paper, and binding, reflect great credit on the publishers. A. C. HOUSTON.

OUR BOOK SHELF.

Elementary Botany. By G. F. Atkinson, Ph.B. Professor of Botany in Cornell University. Pp. xxiii + 444. (New York: Henry Holt and Co., 1898.)

THIS is one of the best little books of its kind it has been our lot to look through for a long time. Pleasantly written, admirably printed and illustrated, it forms an excellent introduction to the study of the science of botany, and Prof. Atkinson is to be congratulated on the way which he has fulfilled the task he has set himself.

The book opens with a general account of a plant-cell and protoplasm, and the student is led through a simple course of vegetable physiology to investigate the ways in which plants live, move, and have their being. This method of beginning with physiology is novel, and there is a great deal to be said for it. It is calculated to arouse the interest which in the minds of all inquiring people, be they children or adults, always accompanies experiment. Prof. Atkinson has wisely limited his selection of experiments to those which require apparatus of only the simplest kind, but they are for the most part experiments which give an insight into the marvellous organisation and concomitant functional complexity which are characteristic of plant-life in general.

Then there follows an elementary account of the main groups of the vegetable kingdom, illustrated by well-chosen types. But the author by no means limits himself merely to these, and the connections and relationships of the different groups are clearly indicated. The chapters on Gymnosperms, which include a good account of the occurrence of antherozoids in Gingko and in the Cycads, are especially good.

The chapters on the general morphology of the flowering plant are perhaps rather advanced, and it might be questioned whether a little more attention to external morphology might not be desirable. The part of the book specially dealing with natural orders strikes us as the least attractive part of the book; but also it is far the most difficult, within narrow limits of space, to render either interesting or educationally valuable. Possibly in a future edition of the work the author may see fit to expand this part by the inclusion of more indications of the facies of, as well as of the trend of differentiation in, the different natural orders, even if the characters of biological interest have to be omitted.

The latter class of characters (biological) are, however, specially treated in the division on Ecology. In this part of the book the author has brought together, in addition to well-known examples, the fruits of his own observation in a country in which such research cannot but yield fruitful results. And the advanced, as well as the elementary, student will find much that is new and interesting in these last chapters. Of course the treatment is brief, but it is useful; the figures and many (not, however, all) of the illustrative photographs from nature are quite admirable.

From the above brief sketch it will be seen that the book is one which thoroughly deserves to be commended as calculated to attract instead of (as is too often the case) repelling the beginner. J. B. F.

Animals of To-day, their Life and Conversation. By C. J. Cornish. Pp. xii + 319. (London: Seeley and Co., Ltd., 1898.)

MR. CORNISH is such a bright and entertaining writer, and has also the art of looking at well-worn subjects from such new points of view, that the republication of this series of articles from the *Spectator* may be welcomed by the zoologist as well as by the general reader. The author, it need scarcely be said, makes no pretence to study animals from a purely scientific or systematic standpoint; and regards the various domesticated breeds as meriting fully as much attention as their wild relatives. The adaptation of animals to their surroundings, the manner in which they exist under what appear to us unfavourable conditions, their speed, their antipathies, their susceptibility to human diseases, and their mental capacities and disabilities, form, indeed, some of his favourite subjects. But he also gives dissertations on the beauty and suitability to their uses of several domesticated breeds; while his chapters on acclimatisation, game-preservation, and, above all, on the terrible devastation inflicted on big game by "skin-hunters," are of almost absorbing interest.

In the commercial aspect of the subject, Mr. Cornish shows that while myriads of South African animals have been recklessly exterminated for the sake of their skins, yet that in Australia, where the marsupials are killed off in thousands from necessity, their valuable furs are for the most part wasted. And here it may be mentioned that, in referring to the commercial quotations of South African skins, the author makes merry at the inclusion of those of the "quagga," on the ground that the animal so-named is now extinct; but he ought to have known that at the Cape this title is universally applied to Burchell's zebra.

As beasts of burden for routes like that to the Klondike, the author speaks enthusiastically of the reindeer and Bactrian camel. Of the latter animal he observes that Englishmen have no practical experience; but if he had read the records of the second Yarkand expedition, he might have somewhat modified this statement. Wider reading might, indeed, in several cases have been an advantage to the author. For instance, in the chapter on "Thirsty Animals" he is very sceptical as to the power of any mammals to exist for a length of time without access to water; suggesting that the well-known instance of the giraffes in the Kalahari may be due to the presence of undiscovered sources of water in the interior of that desert. Had he been acquainted with Mr. W. T. Blanford's observations on the existence of certain Indian mammals in waterless districts, his scepticism might have been removed. Again, in another place, he is under the impression that wild dogs (*Cyon*) are nearer to domestic dogs than are wolves and jackals.

Such slight blemishes detract, however, but little from a very entertaining and instructive volume. Had we more writers of Mr. Cornish's stamp, the popularity of zoology, great as it undoubtedly is, would probably be largely augmented; and his present work can scarcely fail to increase his reputation as a successful writer.

R. L.

Text-book of Algebra. By G. E. Fisher, M.A., Ph.D. and I. J. Schwatt, Ph.D. Part I. Pp. xiv + 684 (Philadelphia: Fisher and Schwatt, 1898.)

ON the whole this is a sound and instructive book. In the chapters on first principles the distinction between signs of operation and signs of quality has been very properly emphasised by a special notation, instead of being ignored; the treatment of systems of equations is excellent; and that of surds is much better than usual, although exception might be taken to some of the notation, and the existence of $\sqrt{2}$ as a definite number cannot be proved (as the authors seem to think) by considering the diagonal of a unit square. The book is rather unequally written, and errors sometimes occur which contrast curiously with the accuracy which generally prevails. Thus in the proof of the remainder theorem the same symbol Q is used for two entirely different things; it is assumed without proof that if r is a proper fraction r^m be-

comes infinitesimal as n increases indefinitely; and it should have been stated explicitly that i is a *definite* symbol obeying the law $i^2 = -1$, together with the usual laws of operation, and that if a is positive $\sqrt{-a}$ is understood to mean $\sqrt{a} \odot i$. If these last precautions are not taken, it cannot be proved, for instance, that $\sqrt{-a} \times \sqrt{-b} = -\sqrt{ab}$, and, in fact, the authors' treatment of this identity is defective. Then such problems as "factor $a+b$" are perfectly unmeaning, especially after chapters on surds and complex numbers; probably the answer intended is $(\sqrt{a}+i\sqrt{b})(\sqrt{a}-i\sqrt{b})$, but any number of others might be constructed, for instance $(\sqrt{a}+\sqrt{b}+\sqrt[4]{4ab})(\sqrt{a}+\sqrt{b}-\sqrt[4]{4ab})$, and so on. It ought to be unnecessary to say that all questions on factors should be put in a perfectly definite way.

It is a pity that the elementary theory of graphs has not been included; every teacher who has tried the experiment must have realised the value of plotting off the graphs of even the simplest functions such as x, x^2, $x/(1-x)$, and so on. Another remarkable fact is that not a single word is said about partial fractions: this is a serious omission, and, in fact, a whole chapter on rational functions might be added with advantage.

This volume ends with a chapter on the binomial theorem for a positive integral exponent. The examples are very numerous, and appear to be well graded: they are intended to provide teachers with alternative sets for different years. The student should on no account try to work them out *seriatim*. G. B. M.

Distribution de l'énergie par courants polyphasés. By J. Rodet. Pp. 338. (Paris: Gauthier-Villars, 1898.)

THE present work is perhaps, in point of thoroughness of treatment, the best on this subject we have yet seen. It is written, not as an introduction to a hitherto unknown subject, but as an account of a well-established branch of engineering.

In this country, the comparative absence of water-power near our industrial centres, and the resulting small demand for long-distance power-transmission, has led to a relative indifference to this important subject. What limited field for such transmissions does exist, seems at present to arise rather from the vastness of our towns, than from the existence of available water-power.

The economy in electrical transmissions of energy, which accompanies the employment of high-pressure currents, has led to the use of the readily-transformed alternating current. And while, as M. Rodet remarks, electric lighting can be carried out equally well with single-phase currents as with polyphase, yet, for purposes of motive power, the absence of a good motor to run on single-phase circuits, and the excellence of the rotary field motor, necessitates the use of polyphase currents by which alone the rotary magnetic field can be produced.

Starting with an historical summary, M. Rodet deals successively with generator, line, and motor. While keeping the essentially practical aspect of his subject in view, and citing from time to time, by way of illustration, the conditions of actual installations, the author, nevertheless, does not hesitate to launch into ample theoretical investigations where he deems these called for. At the conclusion of the main part, a short but interesting chapter on meters for polyphase currents is given.

Of more general interest, however, are the descriptions of installations. These form a most interesting conclusion to the work. We observe that just one quarter of the examples selected by the author as types for description are two-phase transmissions; the rest are three-phase installations, and these include several of importance in south-west France.

The illustrations are for the most part simple and clear. English readers will feel the lack of an alphabetical index, and would prefer to have titles to the illustrations. The work should, however, prove of great value to engineers who wish to make a special study of polyphase current machinery. D. K. M.

My Horse; My Love. By Sarah Buckman-Linard. Pp. xii + 227. (London: T. Fisher Unwin, 1898.)

IT is a little difficult to classify Mrs. Buckman-Linard's book. It is not a treatise, nor a text-book, nor a story. It is written in a conversational style not always easily followed. Here is a sentence which demands exceptional powers of perception:—"In some the odour is perceptible to themselves only, while in others it is such a powerful means of defence as to make the pursuing victim wish he had never been born, which floods cannot drown nor fires quench, if any part escape, and only six feet of earth can extinguish" (p. 22). The book is divided into chapters, but the title of the chapter is little indication of its contents; *e.g.* Chapter ii. is headed "Facilities for Breeding in America," and after a few generalisations on the subject mentioned in the title the following questions are dealt with:—Is it possible that human beings have the same diseases as horses? Are the symptons easily recognised (reference is made to the symptons of glanders)? Is it possible to mend a broken leg? Chapters are also included on jockeys, the Derby day, and training. At the same time there is a quantity of information about the horse, scattered here and there in the volume; and if it had been systematically arranged in half the compass, it might have proved useful.

Matter, Energy, Force and Work. By Silas W. Holman. Pp. xiv + 257. (New York: The Macmillan Company, 1898.)

PROF. HOLMAN here addresses students and teachers of physics and chemistry on the concepts and definitions of physical science. Some knowledge of the experimental side of the subject and its phenomena and laws is assumed, and the logical expression and sequence of the ideas put forward should prove of great value to engineers, and others who have to apply physical and chemical knowledge, in enabling them to think clearly when dealing with the fundamental ideas on which all successful practice must be based. The book is divided into two parts: the first is concerned with a consideration of matter, motion, energy, force and work; the second with the kinetic theory of gases, Le Sage's theory of gravitation, the vortex-atom theory, and the nature of energy and matter. Prof. Holman describes the first part as "a sporadic attempt at clear, consecutive setting forth of individual thought," the second as intended "to give more concreteness to the concepts than could properly be introduced into the first part." The volume deserves to be widely read.

The Way the World Went Then. By Isabella Barclay Pp. xiv + 153. (London: Edward Stanford, 1898.)

THE author of this volume did not live to see it through the press, and the MS. has been edited by two lady friends, who contribute the preface and a summary of three pages, in which they state what they think the author would have included in the second part of her work had she lived. It would be unkind to subject a volume produced under these conditions to severe criticism, and we will merely say that, although the book affords evidence of a fervent desire to present the earth's history in a simple and interesting manner, it is seriously misleading in many matters of fact. and unequal in treatment. The volume is daintily bound, and has some attractive illustrations.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Fourier's Series.

IN reply to Mr. Love's remarks in NATURE of October 13, I would say that in the series

$$y = \sin x + \tfrac{1}{2}\sin 2x + \;.\;.\;.\; + \frac{1}{n-1}\sin(n-1)x + \frac{1}{n}\sin nx,$$

in which $\frac{1}{n}\sin nx$ is the last term considered, x must be taken smaller than π/n in order to find the values of y in the immediate vicinity of $x = 0$.

If it is inadmissible to stop at "any convenient nth term," it is quite as illogical to stop at the equally "convenient" value π/n. ALBERT A. MICHELSON.

The University of Chicago Ryerson Physical Laboratory, Chicago, December 1.

I SHOULD like to add a few words concerning the subject of Prof. Michelson's letter in NATURE of October 6. In the only reply which I have seen (NATURE, October 13), the point of view of Prof. Michelson is hardly considered.

Let us write $f_n(x)$ for the sum of the first n terms of the series

$$\sin x - \tfrac{1}{2}\sin 2x + \tfrac{1}{3}\sin 3x - \tfrac{1}{4}\sin 4x + \&c.$$

I suppose that there is no question concerning the form of the curve defined by any equation of the form

$$y = 2f_n(x).$$

Let us call such a curve C_n. As n increases without limit, the curve approaches a limiting form, which may be thus described. Let a point move from the origin in a straight line at an angle of 45° with the axis of X to the point (π, π), thence vertically in a straight line to the point $(\pi, -\pi)$, thence obliquely in a straight line to the point $(3\pi, \pi)$, &c. The broken line thus described (continued indefinitely forwards and backwards) is the limiting form of the curve as the number of terms increases indefinitely. That is, if any small distance d be first specified, a number n' may be then specified, such that for every value of n greater than n', the distance of any point in C_n from the broken line, and of any point in the broken line from C_n, will be less than the specified distance d.

But this limiting line is not the same as that expressed by the equation

$$y = \underset{n=\infty}{\text{limit}}\; 2f_n(x).$$

The vertical portions of the broken line described above are wanting in the locus expressed by this equation, except the points in which they intersect the axis of X. The process indicated in the last equation is virtually to consider the intersections of C_n with fixed vertical transversals, and seek the limiting positions when n is increased without limit. It is not surprising that this process does not give the vertical portions of the limiting curve. If we should consider the intersections of C_n with horizontal transversals, and seek the limits which they approach when n is increased indefinitely, we should obtain the vertical portions of the limiting curve as well as the oblique portions.

It should be observed that if we take the equation

$$y = 2f_n(x),$$

and proceed to the limit for $n = \infty$, we do not necessarily get $y = 0$ for $x = \pi$. We may get that ratio by first setting $x = \pi$, and then passing to the limit. We may also get $y = 1$, $x = \pi$, by first setting $y = 1$, and then passing to the limit. Now the limit represented by the equation of the broken line described above is not a special or partial limit relating solely to some special method of passing to the limit, but it is the complete limit embracing all sets of values of x and y which can be obtained by any process of passing to the limit.

J. WILLARD GIBBS.

New Haven, Conn., November 29.

FOURIER's series arises in the attempt to express, by an infinite series of sines (and cosines) of multiples of x, a function of x which has given values in an interval, say from $x = -\pi$ to $x = \pi$. There is no "curve" in the problem. Curves occur in the solution of the problem, and there they occur by way of illustration. There are two sorts of curves which occur. In the first place, taking $\phi(x)$ as the function to be expressed by the series, and $f(x)$ as the sum of the series, we have the curves $y = \phi(x)$ and $y = f(x)$, the graphs of the two functions. These coincide wherever the series expresses the function; but, if the function $\phi(x)$ is one which cannot be expressed by a Fourier's series for all values of x in the interval, the curves do not coincide throughout the interval. In the second place, taking $f_n(x)$ as the sum of the first n terms of the series, we have the family of curves $y = f_n(x)$, the graphs of $f_n(x)$ for different values of n. As n increases the graphs of $f(x)$ and $f_n(x)$ approach to coincidence in the sense that, if any *particular value* of x is taken, and any small distance d is specified, a number n' may then be specified such that for every n greater than n', the difference of the ordinates of the two curves is less than d. But this is not the same thing as saying that the curves tend to coincide geometrically, and they do not in fact lie near each other in the neighbourhood of a finite discontinuity of $\phi(x)$. It is usual to illustrate the tendency to discontinuity of $f(x)$ by noting the form of the curve $y = f_n(x)$ for large values of n, but the shape of this curve always fails to give an indication of the sum of the series for the particular values of x for which $\phi(x)$ and $f(x)$ are discontinuous. This is the case in the example cited by Prof. Willard Gibbs, where all particular values between $-\pi$ and π are equally indicated by the curve $y = f_n(x)$, but the sum of the series is precisely zero.

May I point out that there is some ambiguity in the expression "the limiting form of the curve" used by Prof. Willard Gibbs? Taking his example, it is quite true that n' can be taken so great that, for every n greater than n', there is a point of C_n within the given distance d of any point on the broken line, but this statement is not quite complete. It is also true that a number n can be taken great enough to bring the point of C_n on *any assigned* ordinate within the given distance d of its *ultimate position* on the broken line, but it is further essential to observe that no number n can be taken great enough to bring *every* point of C_n within the given distance d of its ultimate position on the broken line. The number n which succeeds for any one ordinate always fails for some other ordinate. Suppose, to fix ideas, that we take a point on C_n for which $y = 1$, and x is nearly π, so that $\pi - x$ is less than d, and keeping x fixed, observe how y changes when n increases; it will be found that, for values of m very much greater than n, the ordinate of C_m, for this x is very nearly π, and we can in fact take m great enough to make this ordinate lie between π and $\pi - d$. In words, the representative point, which begins by nearly coinciding with a point on a vertical part of the broken line, creeps along the line, and ends by coinciding with a point on the oblique part of the broken line. This will be the case for every value of x, near $x = \pi$, with the single exception of the value π. Thus, in the passage to the limit, every point near the vertical part of the broken line disappears from the graph, except the points on the axis of x. This peculiarity is always presented by a series whose sum is discontinuous: in the neighbourhood of the discontinuity the series does not converge uniformly, or the graph of the sum of the first n terms is always appreciably different from the graph of the limit of the sum.

In this way the graph of the sum of the first n terms fails to indicate the behaviour of the function expressed by the limit of this sum, and we may illustrate the distinction between the two, as Prof. Willard Gibbs does, by considering the intersections of the graph with lines parallel to the axis of x. Keeping y fixed, say $y = 1$, we may find, in his example, a number n, so that there is a corresponding value of x differing from π by less than d, and then, allowing n to increase indefinitely, we shall get a series of values of x, having π as limiting value. But this limiting value is *not attained*. In Prof. Willard Gibbs's notation, the equation $2f_n(x) = 1$ has a root near to π when n is great, and n can be taken so great that the root differs from π by less than any assigned fraction; but the equation

$$\underset{n=\infty}{\text{limit}}\; 2f_n(x) = 1$$

has no real root. In fact Prof. Willard Gibbs's "limiting form of the curve" corresponds to limits which are not attained: but the limiting form in which the vertical portions of the broken line are replaced by the points where they cut the axis of x corresponds to limits which are effectively attained. It is the

latter limiting form, and not the former, which is the graph of the sum of the Fourier's series.

The matter here discussed is perhaps that referred to by Prof. Michelson in Nature of October 6, but I did not understand his letter so. In regard to his present communication, I agree with him if he means that it is just as necessary, in tracing the part of the curve C_n near the vertical part of the broken line, to take a particular value of n, as it is to keep x within a narrow range of values corresponding to n. But this admission is not equivalent to admitting that an infinite series may be summed by stopping at any particular term. Rather it confirms the conclusion, explained above, that the graph of the sum of the infinite series contains no vertical line.

December 22. A. E. H. Love.

The Schmidt-Dickert Relief Model of the Moon.

The present location of the Schmidt-Dickert relief model of the moon is probably not generally known in Europe. Webb's "Celestial Objects for Common Telescopes" (edition of 1896) states that the model is in Bonn, and this impression probably generally prevails. As a matter of fact the model has been for about twenty years in America. It has been on exhibition only at rare intervals during the time, however, and hence has been lost sight of. By a disposition recently made of it, it has fortunately become available to students of science and the public generally. Through the generosity of Mr. Lewis Reese, of Chicago, it has been presented to the Field Columbian Museum, and is now installed in this institution.

The model is in the form of a hemisphere about nineteen feet in diameter, and upon its surface are shown, in proportional relief, over 20,000 distinct localities. In his original description, Dr. Schmidt, the eminent selenographer, states that the details were based on the chart of Beer and Madler, but many features were added from his own observations. He also states that he carefully guided and watched over the work of construction, and with his own hand tested its correctness in all essential particulars. These statements give sufficient assurance of the accuracy of the model, and the confidence with which it may be studied. It is probably the best substitute extant for a trip to the moon. Oliver C. Farrington.

Field Columbian Museum, Chicago, December 12.

Maxwell's Logic.

In a paper on the experimental verification of Ohm's law (Brit. Assoc. Report, 1876), Maxwell makes the following statement.

"Assume that the resistance of a given conductor, at a given temperature, is a function of the strength of the current. Since the resistance of a conductor is the same for the same current, in whichever direction the current flows, the expression for the resistance can contain only even powers of the current."

It seems to me that such an argument is not applicable to a case of this kind.

Consider, for example, the flow of a liquid along a capillary tube. We might define the resistance of any portion A B of such a tube to be the ratio of the difference of pressure between A and B to the quantity of liquid flowing across any section in unit time.

Now would it not be equally legitimate to apply the above reasoning to this case, and prove that the resistance of a capillary tube could not vary as the first power of the velocity? Although of course, there may be no physical analogy between flow of liquid and electric current. Again, imagine a uniform wire A B along which a current of electricity is flowing, the ends A and B dipping into mercury cups (say). Now, instead of reversing the direction of the current, let the wire be turned end for end. Surely there is no difference between this and the previous case, and yet the current in the wire is reversed.

John Lister.

Royal College of Science, London, South Kensington, S.W., December 12.

LORD IVEAGH'S GIFT.

The announcement, made in the daily papers last week, of Lord Iveagh's intention to devote the princely sum of 250,000*l.* to the endowment and promotion of bacteriological research in England, has arrested the attention of the country and of every class of the community. The humane and enlightened sentiments that have actuated Lord Iveagh, and the liberal manner in which these have been given effect, constitute a unique claim to the gratitude and appreciation of his fellow countrymen.

The distinction of such gifts had hitherto remained, and appeared likely to remain, the prerogative of America and American millionaires. The open-handed liberality of Rockfeller, Armour and many others has enabled the United States to provide endowment for research and to equip laboratories on a scale of completeness unattempted in the mother country, whilst on the continent the scientific worker has long found encouragement and support in State-aided institutions. The result has been that in bacteriological as well as other branches of inquiry England has lagged behind.

Lord Iveagh's decision to devote the proposed endowment to an Institute that had been endeavouring with inadequate means to carry out the work with which he sympathises, has met with widespread approval. It is now seven years since the British Institute of Preventive Medicine was founded with the view of establishing in England a national home for bacteriological work and inquiry. The scheme received its inception at a meeting held at the Mansion House, and from the first obtained the sympathy and support of eminent men of science and members of the medical profession. A fund was raised at the same time to provide poor patients with the means of proceeding to Paris to undergo the Pasteur treatment for rabies. This fund is still administered by the Institute, and no year has passed without several claims being made for its help.

The new Institute was duly incorporated under the Companies Act, and a Council was appointed to further its objects—first amongst these being investigations in connection with the prevention and treatment of infectious diseases. The Council elected represented all branches of scientific work likely to be benefited by bacteriological investigation, and the work of the Institute was thus at the outset wisely placed on the broadest possible basis.

The services of Lord Lister, as Chairman of Council, and of Sir Henry E. Roscoe, as Hon. Treasurer, have been of inestimable value to the fortunes of the Institute. The liberality of the Grocers' Company and of private individuals, along with a handsome donation from the Trustees of the late Mr. Berridge, enabled the Council to take steps to acquire a building site. A favourable site was acquired on easy terms at Chelsea, through the liberality of the Duke of Westminster, and building operations were commenced. The amalgamation of the College of State Medicine with the Institute was effected at the same time, and in this way temporary premises were acquired at Great Russell Street for the initiation of work. The Institute occupied these premises during four years, and the various departments to be established at Chelsea were successfully organised through the efforts of a small but zealous staff. The discovery by Behring of the antidiphtheria serum, and its beneficial use abroad, led the Institute to undertake its preparation for the first time in this country. A farm was rented at Sudbury, near Harrow, and provided with laboratory and stabling accommodation, and the preparation of the serum commenced. A public appeal was made for funds, and a sum of money, sufficient to pay the initial expenses of the new departure, was raised. The work of the antitoxin department of the Institute has since then greatly expanded—the antistreptococcus and antitetanus serum being now prepared, as well as the diphtheria serum, and placed at the disposal of medical men. The Institute also undertook the preparation of tuberculin and mallein for diagnostic purposes.

The work undertaken in the antitoxin and other departments proved a serious drain on the resources of the

Institute, and the Council, after careful consideration of the financial position, most reluctantly decided to abandon completion of the original plan of the Institute, and to leave it an unfinished building. The plans were accordingly modified by the architect, and a portion of the building was proceeded with and completed last year. The Institute took possession of the new building in May of this year, when the fittings of the main laboratories were completed. The fittings of the building, as it at present stands, are now all but completed. A most promising start has been made, and the facilities for investigation and instruction are being widely taken advantage of.

The Jenner Memorial Committee decided last autumn to transfer any funds it might receive to the Institute. The Council, in view of this, decided to alter the title to the Jenner Institute, and in this way to commemorate permanently the memory of Jenner and his work. The necessary legal formalities were completed on the 6th inst., and the Institute from that date continued its work as the Jenner Institute of Preventive Medicine.

Lord Iveagh was a generous contributor to the Jenner Fund. At the same time, the financial outlook was by no means rosy—working expenses had greatly increased at Chelsea; the salaries of the staff were insufficient, and subscriptions were coming in slowly. These facts were causing serious anxiety to those responsible for the management of the Institute. On December 20, Lord Lister was able to communicate to the Council of the Institute Lord Iveagh's munificent offer, along with the conditions attached to it. The public announcement of this noble gift and its cordial acceptance was made by Lord Lister and Sir Henry Roscoe in a letter to the press on the 23rd inst. The letter states that the bequest is given on the condition that in future the control and mangement of the affairs of the Institute be placed in the hands of a new Board of seven Trustees, three of the seven to be chosen by the Council of the Institute, three by the donor, and one by the Council of the Royal Society.

It is further proposed that the building of the Institute at Chelsea be enlarged, and the original scheme of the same completed; that the sadly inadequate salaries of the director and other members of the staff be increased, and that valuable scholarships and studentships in connection with the Institute be established. There are, of course, many details to be arranged and settled; but it will be seen that the scheme is far-reaching, comprehensive and carefully thought out, whilst the conditions attached are by no means onerous.

The rare modesty of the donor will not, we feel sure, prevent the realisation of the general wish that his name be gratefully and permanently associated with the beneficent work he is about to inaugurate.

Amongst the first results will be, as desired by Lord Iveagh, the completion of the Chelsea building; and the foundations being already laid, this can be proceeded with without delay. The provision to be made for an adequate emolument to the members of the staff, along with the establishment of scholarships and studentships, will furnish an incentive and encouragement hitherto lacking to workers in this field. Many promising researches have of necessity been postponed at the Institute, through the difficulty in finding sufficient assistance to carry them out. Large questions can now be attacked, and the time ungrudgingly given to their elucidation by properly trained experts. A small stream of research work has issued from the Institute; this will be widened and deepened. The students, who have come from all parts of the country and the empire for instruction in bacteriology and preventive medicine, will increase in numbers with the unique facilities that will be placed at their disposal.

The establishment of a British and Imperial Institute of Bacteriology is now within a measurable distance of realisation. The present building at Chelsea contains, amongst its main features, the following departments:—(1) The bacteriological laboratories, devoted to bacteriological investigation and instruction in connection with medicine, public health, and the pathology of disease. (2) The chemical and water laboratories, dealing mainly with water, soil, air, and food, in their hygienic aspects. (3) The Hansen laboratory, dealing with the practical applications of bacteriology to agriculture, brewing, dairy and other industries. (4) Research rooms for advanced workers, and museum and lecture theatre. (5) The requisite facilities for experimental work and investigation in connection with the causation and prevention of disease.

This work will now be placed on a sure and permanent basis, and the Institute will be brought fully abreast with the best foreign laboratories devoted to bacteriology. Through Lord Iveagh's munificence, the objects for which the Institute was established can now be developed on a scale commensurate with their importance.

ALLAN MACFADYEN.

GEORGE JAMES ALLMAN.

IN George James Allman, who died at his residence, Ardmore, Parkstone, Dorset, on Thursday, November 24, at the advanced age of eighty-six, zoological science has lost a zealous and most accomplished worker, the world a great man. He was born at Cork in 1812, being the eldest son of Mr. James Allman, of Bandon, in that county, and was educated at the Belfast Academical Institution, originally for the Bar. As with so many others born to science, he early drifted into paths most congenial to his nature, and accordingly graduated in Arts and Medicine in the University of Dublin. He became a member of the Royal College of Surgeons, Ireland, in 1842, and a Fellow in 1844, and took his M.D. (University, Dublin) and (University, Oxford) in 1847. He from early days displayed a passionate devotion to the study of organic nature, and so highly was he esteemed that during the year of his graduation he was appointed Regius Professor of Botany in the Dublin University. Here the late Professor of Geology, Beete-Jukes, was one of his most intimate friends. Thus embarked on a career of scientific work and investigation, Allman gave up all thought of the medical profession, and ten years later resigned the Dublin chair for that of Regius Professor of Natural History in the University of Edinburgh, with which was incorporated the Keepership of the Natural History Museum, and these combined offices he held until 1870, when he retired into private life. In Edinburgh he was no less a favourite than in Dublin; and his lifelong friendship with the late Lord Playfair, Lord Shand, and many of his most brilliant contemporaries began in that good old town, where he built himself the house in Manor Place, where his clever and charming wife made so happy a home for himself and his friends. During his period of activity in the two great capitals named, Allman laboured with untiring zeal, ever intent on the progress of science and the best interests of those who came under his charge. On his retirement, first to London and afterwards to Parkstone (Dorset), his energy never flagged, the most conspicuous change in his actions being the substitution of the personal care of a small but very picturesque estate of five or six acres at Parkstone, having great possibilities for a naturalist and lover of outdoor life, for the more fatiguing duties of the reception- and drawing-room, encumbent upon him in his professorial capacity. Not that Allman despised the latter, for, on the contrary, while in Edinburgh especially, his drawing-room was the rendezvous of the cultured, drawn together by

the personal charm and gifted influence of his wife, to whom he owed much of his popularity and success. Playfair and Shand may be named among the more regular attendants at these gatherings; but Allman, a born field-naturalist, full of vigour, yearning for the open, found his greatest contentment in the field, and in dredging expeditions, in which both in Ireland and Scotland he took the most ardent interest.

As a worker Allman was untiring and prolific, and between the years 1835–1873, apart from his monographs, which are alone monumental, he produced considerably over 100 papers, mostly to be found in the publications of the Royal and other learned Societies of London, Dublin and Edinburgh, in the *Annals and Magazine of Natural History*, and elsewhere; and while in later years he became less prolific, we find him working to the last, and as late as 1897 contributing (Phœnix-like to the younger generation of naturalists) a paper (*Jour. Linn. Soc. Zool.*, vol. xxv. p. 517) on the hybernaculum of the common snail, embodying a most interesting observation overlooked, because always present, by the multitude who had yearly dissected the animal. Many of the miscellaneous papers by which he will be best remembered are "Reports," such as those of the "Porcupine"; and by association with Bowerbank, the elder Carpenter, Hancock, Hincks, Gwyn Jeffreys, Wyville Thomson, and others, he will be ranked among the earlier pioneers in the study of the marine zoology of Britain, whom he was almost the last survivor. His work upon the freshwater forms, especially as involving the Polyzoa, and his long intimacy with his great personal friend Busk, is little less noteworthy and historically important. Contemporary of Owen, friend of Huxley, correspondent of the elder Agassiz, truly does it seem that with his decease a link with the historic past has been lost; but among giants who survive him Hooker remains, as one who, with Alex. Agassiz, McIntosh, and Norman, has been his counsellor and friend.

Allman was as versatile as voluminous and proficient, since his papers deal with well-nigh all the great groups of animals, between and including the Protozoa and Mammalia. Recent and fossil forms had for him a like interest; and to have passed as a solid worker from the study of the arteries of the Armadillos through that of a fossil Seal, an Ophiurid, and the Graptolites, to the Peridiniaceæ, working the meanwhile at all sorts of Invertebrates, at questions physiological, anatomical, developmental, and taxonomic, taking by the way the study of parasitism, fermentation, and even of snow-crystal formation, is to have established a record worthy of the emulation of the serious science student. Allman's first paper was a botanical one, "On the Mathematic Relations of Forms of Cells of Plants," and it is worthy of note that in this he in a sense anticipated one of the most recent among our biological departures. He is to be seen at his best as a casual investigator of his time, in his papers on the development and palæontology of the Crinoids and on the Potamogale, a young specimen of which he described. His greater reputation, however, rests upon his monumental investigations into the classification and morphology of the Cœlenterata and Polyzoa, upon which he has left a mark for all time. His first paper on the Polyzoa appeared in 1843—his great monograph on the fresh-water members of the class in 1856; while his first paper on the Hydrozoa was published in 1844, and his epoch-making "Gymnoblastic or Tubularian Hydroids" was completed in 1872. During the thirteen years thus apparently occupied in the preparation of the first and the twenty-eight in that of the second, he was active in the production of numerous papers dealing with both groups of animals, and on the Cœlenterata alone he published up to the period named close upon fifty papers all told. His original descriptions of *Rhabdopleura*, *Myriothela*, *Limnocodium*, sufficient in themselves to have made him famous, stand conspicuous in contemporary scientific literature, and in his reports upon the Hydroids of the *Challenger* expedition and on the Hydroids obtained during the exploration of the Gulf Stream under the direction of the United States Government, his work will remain memorable in the later progress of marine zoology. Of his *magnum opus* the "Gymnoblastic or Tubularian Hydroids," it may be said that its appearance marked an epoch in the history of the scientific investigation of the Cœlenterata. This glorious work, pre-eminent among the magnificent monographs of the Ray Society, came as a revelation to the zoologists of the time. Its classical companions, the "British Naked-eyed Medusæ" of Forbes and the "Oceanic Hydrozoa" of Huxley, had paved the way for its appearance, by extending our knowledge and simplifying our conceptions of the complex structure of the Colonial Hydrozoa. Johnston's "British Zoophytes" was still a leading work of reference on the group, and Reay Greene's "Manual of the Cœlenterata" had enticed to the study of the class many a student who might have strayed into other paths. Allman's monograph, with its 400 pages of text, clear, comprehensive, and logical, with its twenty-three exquisite coloured plates (faithful copies of their author's original drawings, which even in those days had to be engraved in Germany), came as the fulfilment of a great promise. Its first part, dealing in general terms with the morphology, physiology, and chorology of the Hydrozoa, with its masterly "Glossology," ranks among the most perfect and philosophic of all modern zoological treatises. The exquisite beauty of its illustrations, in respect to which it vies with other scientific works of its time, is no less remarkable than the consummate pains bestowed upon its pages. It is a perfectly ideal treatise, finished and artistically complete in all its parts, and it is not too much to say that it revolutionised and placed upon a solid foundation for all time our knowledge of one of the most perplexing of nature's handiworks. Its influence on contemporary investigation in zoology has been far reaching, and had its author achieved nothing beyond it he would have left an ineffaceable mark upon time. Much of the work which constitutes its foundation was done in Irish waters, which thereby became classical ground in the investigation of the British Cœlenterates, so successfully continued at present for the Actinozoa by Haddon and his pupils and associates, and for the Hydrozoa by Brown and the Misses Delap.

Beyond his professorial and research work, Allman was active in the popularisation of zoology. He was among the earlier supporters of the British Association, his first papers having been read before it. He in 1873 presided over its Biological Section, and was in 1879 President of its Sheffield meeting. He was in 1855 appointed one of the Commissioners of Scottish Fisheries, which post he held until the abolition of the Board in 1881, and in 1876 was one of those selected to inquire into the working of the Queen's Colleges in Ireland. During the years 1874–1881 he was President of the Linnean Society, succeeding Bentham. In this capacity he was not altogether a success as a chairman; but by his solicitations on behalf of the Society—and his presidential addresses—he did much to further its welfare. Those on the Protozoa, delivered consecutively during his first two years of office, which, together with his remarkable monograph on the fresh-water Medusa (*Limnocodium Sowerbyi*), which also appeared in the Society's Journal, admirably illustrated by woodcuts from the facile hand of Ferrier, amply testify to his desire to be of use to the Fellows of his Society, so adequately expressed in the peroration to his 1877 address.

Allman served on the Councils of the Royal Societies

of London and Edinburgh, and of the Royal Irish Academy, and he officiated as examiner in natural history for the Queen's University of Ireland, the University of London, the army and navy and Indian Medical Service, and for the Indian Civil Service. He was in 1854 elected a Fellow of the Royal Society, and in 1873 received the Society's Royal Medal. He was in 1877 awarded the Brisbane Gold Medal of the Royal Society of Edinburgh, and in 1878 the Cunningham Gold Medal of the Royal Irish Academy, while in 1896 he received the Gold Medal of the Linnean Society he had served so well. In 1879 there was conferred upon him the Hon. LL.D. of the University of Edinburgh.

On his retirement into private life Allman settled in Dorsetshire, on the genial slope of the ridge overlooking Poole Harbour, there to devote himself to his outdoor pursuits and to horticulture, which was with him a passion; and it is not a little remarkable that he, who in earlier years had committed himself to the views concerning man's place in nature expressed in a short paper he in 1889 read before the Royal Society of Edinburgh, should have had for friend and neighbour in the closing years of his life Alfred Russel Wallace, whose views on Darwinism applied to man were so akin to his own. But it is not in this interesting association of these two great men that the Dorsetshire village will alone be hallowed ground to the zoologist of the future, for it also bears testimony to Allmann's loving devotion to his wife, in a manner which associates her directly with his triumphs and pursuits. For her use he therein had built, midst his beautiful garden, a substantial brick house, with a tiled terrace so arranged that she might sit and read and talk to him while occupied with his favourite pursuits. The garden itself is a perfect picture of undulating beauty, covering an area of some five or six acres, its owner having been particularly careful to avoid all suggestion of suburbanism in its design. Bamboos, a Grumera, rhododendrons of great rarity and value, carefully hedged around for protection against cold and wind, rivulets whose banks are flanked by many a botanical treasure, a stream here, the occasional pollution of which filled him with agony expressed in strongest remonstrance—a pond there, the inhabitants of which were individually the care of its owner—the whole a little paradise—one pictures the grand old man, resolute to the last, seated on his favourite tree stump or rustic seat, as for hours he used to watch the unfolding of the tender bud or the ripple of the innocent streamlet. Every plant was known to him, every label bore his handwriting, and all around was the special object of his tender care.

Great as was Allman's love of nature and freedom, the distinguishing features of his character were his manliness and gentlemanly consideration for others, and in combination with an artistic temperament amounting to the poetic, these gave to his individuality a rare charm. In testimony to the former combination, there stands in his drawing-room, foremost among the treasures he prized most highly, a clock, presented to him on the occasion of his retirement from the Edinburgh chair, which bears the following inscription:

To George J. Allman, Esq., M.D.
Professor of Natural History
In the University of Edinburgh,
This Timepiece is respectfully presented
By a few students
Now and formerly attending his lectures,
As a small mark of their sincere regard for him
AS A GENTLEMAN,
And their admiration of his talents
And ability as a naturalist.
29 July, 1870.

His poetic fancy had led him in his later years to commit his thoughts to verse, which it was one of the concluding ambitions of his life to see in print. But in vain—since the small volume of his poems, which he had printed for private circulation, only reached the house on the day of his decease. As to the literary merits of this opinions might differ, but his verses soar above the peevish Heineësques of Albrecht and the laboured mnemonics of Anderson, two among modern zoologists who have been constrained to write poetry, and they have a special value in that they are the expression of the poetic effusions of his mind prompted by actual work in the field and on the water which made him famous, and of which they are largely descriptive. None other than Johannes Müller, the father of comparative anatomy, has remarked: "Die Phantase is ein unentbehrliches Gut"; and the thought arises that the discipline of biological science soars above that of the more rigid and strictly mathematical in the extent to which it stimulates the imagination, one of the highest of the intellectual faculties.

Allman endeavoured to work to the last, and to the end his brain power remained perfect and his sight and hearing good. It is extraordinary how his eyesight remained practically unimpaired by his constant microscopic work extending over some seventy years. Though latterly weakened by asthma, he would day by day sit at his favourite table and write, and he leaves unfinished a book apparently intended for publication in one of the scientific series. His wife predeceased him in 1890, and he had no family; but he was especially fortunate in the loving care of nieces and others who had learned to take an interest in his life work, and who afterwards made his home bright and happy. He had this autumn planned some considerable additions to the garden of which he was so fond, dedicating a portion of it to a favourite grand-niece, "Erica," and there can be little doubt that he never imagined himself failing. But a few hours after what proved to be a farewell visit to his dearly beloved plants, he died quietly in his arm-chair. A steady loss of muscular power throughout his whole system during the past few months apparently extended somewhat suddenly to the heart, and took from the world of science an earnest worker, a man in whom the artistic and philosophic temperament were exceptionally combined, and whose name and influence for good will endure. G. B. H.

DR. H. W. VOGEL.

EVERY one interested in photography—and in these days who is not?—must deeply regret that so eminent a worker as Dr. Vogel has passed away. He was one of the pioneers in the band of investigators in what may, perhaps, be called the second period of the development of photography, dating from the time of the daguerreotype to the introduction of gelatine dry plates. When Fox Talbot and Daguerre made known their wonderful methods of making nature draw her own pictures, he was a lad of six or seven years of age, and it was thirty-four years after this that Dr. Vogel announced his discovery that, by the use of certain colouring matters, it was possible to make a photographic plate sensitive to other colours than those to which it had previously been considered as sensitive. This discovery was of so radical a nature that a considerable number of eminent experimentalists were quoted as having failed to corroborate the observation, and the general idea at the time seemed to be that Vogel's announcement was due to an error in his work. At the present day there is no need to enlarge upon the importance of colour sensitisers, for, practically speaking, the whole art of the correct monochromatic rendering of colours by photography, and of the various indirect methods of producing pictures in natural colours by photographic means, are founded upon their use. The fact that it is rather an increase of sensitiveness than the actual conferment of sensitiveness that is effected, and that Dr. Vogel's theory of the action has not commended

itself to other workers in the same field, are only matters of detail that in no way affect the facts established by him.

Dr. Vogel's activity was shown in almost every branch of photography, and in many of its applications. His astronomical work, especially in connection with eclipses of the sun, is well known. The existence and prosperity of the Imperial Technical High School of Photography, at Berlin, is the best of evidence of his work as a teacher. His "Handbook of Photography," "Practical Spectrum Analysis," and other treatises, will long remain as useful guides. The *Photographische Mitteilungen*, which he established in 1864 and conducted himself until quite recently, and the position that at one time he took up as correspondent of other technical papers, show how much he valued and worked for current photographic literature. There are few men who have done such varied and lasting work in connection with photography as Dr. H. W. Vogel.

NOTES.

WE notice with much regret the announcement that Prof. A. A. Kanthack, professor of pathology in Cambridge University, died on Wednesday, December 21, at the early age of thirty-five.

THE French Société d'Encouragement pour l'Industrie Nationale has received a gift of twenty thousand francs from M. Gilbert (of Givet), to be used for the advancement of French industries.

MR. FREDERICK G. JACKSON, the leader of the Jackson-Harmsworth Arctic expedition, has received a knighthood of the first class of the Royal Order of St. Olaf from King Oscar of Sweden and Norway.

A BIOLOGICAL Section for Agriculture and Forestry has been established in connection with the Imperial Sanitary Bureau at Berlin. Dr. Freiherr v. Tubeuf (of Munich) has been appointed botanist, and Dr. J. Behrens (of Carlsruhe) bacteriologist to the Section.

THE death is announced of Mr. John Barrow, F.R.S., at the age of ninety-one. He took an active part in promoting the search for Sir John Franklin, and was the author of several books of travel and descriptions of glaciers in the Alps. He was elected a Fellow of the Royal Society so far back as 1844.

THE following gentlemen have been elected corresponding members of the Zoological Society:—Dr. Ludwig Heck, of the Zoological Gardens, Berlin; Mr. William T. Hornaday, of the Zoological Park, New York, U.S.A.; Dr. Herman von Ihering, of the Musen Paulista, St. Paulo, Brazil; and Prof. Louis von Méhely, of the National Museum, Budapest.

WE learn from *La Nature* of December 24, that a mountain observatory has been erected at Mont Mounier, the highest point of the Maritime Alps, at 2816 metres above the sea-level, and about 90 kilometres north-west of Nice. The cost of the establishment has been defrayed by M. Bischoffsheim, a member of the Institute, who also endowed the Nice Observatory. The mountain station is connected by telephone with the telegraphic station at the village of Beuil, and meteorological observations are regularly made by M. Maynard. As the position is all that can be desired for the purpose, we may hope for some valuable results in connection with those obtained at the Nice Observatory. During the frosts of winter the temperature at the upper station falls to about 36° F. below the freezing point.

A RECENT number of the *Lancet* contains a paper by Mr. A. F. Stanley Kent, entitled "The Specific Organism of Vaccinia." The author has found a diplo-bacillus present in large numbers in the deeper parts of the vesicle. This organism he has succeeded in cultivating in artificial media, and has been able to produce, by its inoculation into animals, vesicles "indistinguishable from those produced in the ordinary course by vaccination with current lymph." Mr. Kent further states that animals which have been thus inoculated subsequently give no reaction when revaccinated with active lymph. Many investigators have been drawn into this field of research, but hitherto the difficulties of deciding the claims of so many rival candidates have proved insuperable. It will be important to have Mr. Kent's results repeated and confirmed by other workers, and there can be no doubt that his suggestive and promising achievement will give fresh energy to the conduct of experiments in this direction.

THE Shanghai Meteorological Society has issued its report for the years 1896 and 1897. The headquarters of the Society is at the Zi-ka-wei Observatory, of which the Rev. A. Froc, S.J., is Director. The observatory receives daily two or three telegrams from forty-two stations, including those from Corea, Japan, Formosa, and the Phillipines, and issues storm warnings to several ports. The present report contains a discussion of two notable typhoons which occurred on September 9 and 29, 1897. The first of these was of unusual violence; it fell like a thunderbolt upon the city of Yokohama, and caused considerable havoc there and in the neighbouring districts. The storm struck the steamship *Empress of India* in lat. 33° 30′ N., long. 137° 5′ E., on the night of September 8–9, and in the course of two hours the barometer on that vessel fell 1·25 inch, and in less than forty minutes the mercury again rose 1·40 inch. During part of its course the storm travelled at a rate of over fifty miles an hour.

THE effect of approaching storms upon song birds is the subject of an interesting contribution by Mr. C. E. Linney to the U.S. *Monthly Weather Review*. It appears that during the night of August 15–16 very severe electrical, wind, and rain storms prevailed over the northern district of Illinois. An observer in Henry County, Mr. W. W. Warner, noticed that for forty-eight hours before the storm not a sound was heard from the numerous song birds in the district. This observation was so full of interest that Mr. Linney wrote for additional information, with the result that he received numerous letters, some confirming it; others stating that birds sing louder and more persistently before a great storm, and nearly all agreeing that they are more restless than usual at such a time. Mr. Linney has found the following weather proverbs referring to song birds and storms:—When birds cease to sing, rain and thunder will probably occur.—If birds in general pick their feathers, wash themselves, and fly to their nests, expect rain.—Parrots and canaries dress their feathers and are wakeful the evening before a storm.—If the peacock cries when he goes to roost, and, indeed, much at any time, it is a sign of rain.—Long and loud singing of robins in the morning denotes rain.—Robins will perch on the topmost branches of trees, and whistle when a storm is approaching.—The restlessness of domestic animals and barn-yard fowls before an approaching storm is well known, and many of their peculiarities have been noted; but the actions of song birds do not appear to have previously received particular attention.

A FULL and well illustrated account of the manufacture of aluminium at Foyers is contained in *Commerce* for December 14. The works, which were completed at the end of 1896, are now in full operation. The raw material bauxite is obtained in County Antrim, whence it is transported to Larne. At Larne

it is calcined, ground, and treated under pressure with caustic soda solution, whereby sodium aluminate is formed. The clear solution of aluminate is then agitated, and at the end of thirty-six hours deposits 70 per cent. of its burden of alumina. This alumina is dehydrated and heated until it becomes crystalline and non-hygroscopic. In this state it is shipped to Foyers, where it is electrolysed in a bath of cryolite. The total fall of water available at Foyers is 350 feet, and an ample supply at all seasons has been secured by the conversion of two lochs into a reservoir of 4000 million gallons storage capacity—a large engineering enterprise. Seven turbines are at present in action, each capable of developing 700 h.p. when running at 140 revolutions per minute. The dynamos are of large size, the commutators being six feet in diameter, and having 216 segments. Each dynamo has 120 brushes. The carbon electrodes are made by the company at a factory in Greenock. The aluminium turned out at Foyers is not pure enough for all purposes. The refining works are at Milton, in Staffordshire, where plant is provided for an output of four tons daily. Aluminium now at 1*s.* 3*d.* per lb. is bulk for bulk cheaper than copper, brass or tin. The works at Foyers have called into existence a small village, which appears to be well looked after by the directors of the company. It already boasts a club, which provides recreation and instruction for the workmen.

LETTERS have lately appeared in the *Lancet* with reference to the colours of newly-born negro children. Several medical men have given the result of their experience, and the evidence shows that at birth the children are of the colour of a light quadroon. In a paper on the natives of the Warri district of the Niger Coast Protectorate, published in the new *Journal* of the Anthropological Institute, it is recorded that "pure negroes when born are pink, like young rats; at the end of about three or four months they become black." Atmospheric conditions thus seem to be necessary to produce the full black colour of the negro.

THE Anthropological Institute has just published the first number of a new series of its *Journal*. Since the foundation of the Institute an illustrated journal has been issued in quarterly numbers, forming, during the twenty-seven years of its existence, a series of as many volumes, containing numerous papers of great scientific value and interest. The old journal was a demy octavo ($5\frac{1}{2} \times 8\frac{1}{2}$ inches), but the new series is larger, being imperial octavo ($11 \times 7\frac{1}{2}$ inches, nearly). The object of increasing the size is to include ample plates and tables, and bring the journal in general uniformity with the important publications of some of the continental anthropological societies. A number of very interesting papers appear in the first part of the new series, among the subjects dealt with being the ethnography of the Murray Islands, Torres Straits, Australian folk-lore stories, the pigmies of the Upper Welle district of the Belgian Congo, A-bantu and Ashanti skulls and crania, the natives of Tanna, and totemism.

AN interesting paper by Dr. Brinton, on "The Linguistic Cartography of the Chaco Region," has just been reprinted from the *Proceedings* of the American Philosophical Society. The region known as El Gran Chaco, or the Great Hunting Ground, with which the paper is concerned, has always been peculiarly perplexing to students of American aboriginal languages. It lies in northern Argentina and eastern Bolivia, between latitude 18 and 32° South, and longitude 58° and 66 West of Greenwich. Except by the water-ways it is almost impossible to traverse the country, and for that reason extensive tracts of it are still unexplored. Dr. Brinton states that the native tribes who inhabited this region have always been in the lowest stages of culture, depending on hunting and fishing for their subsistence, without settled abodes, migratory and in ceaseless warfare with each other. The self-sacrificing efforts of the Jesuit and Franciscan missionaries have at times succeeded in gathering a few hundred together about some mission, only to be dispersed again on some slight cause. Thus, some years ago, in the middle of the night, the whole of the tribe of Penoquiquias, which had been converted and induced to take up a fixed abode, suddenly disappeared, and were never seen again. Dr. Brinton discusses recent contributions to the linguistic ethnography o the Chaco region, and offers some suggestions for the correct classification of tribes of still uncertain affinities.

ON September 20 and 21, 1897, two strong earthquakes were felt in the island of Labuan, near Borneo, the pulsations of which were registered by magnetographs at Batavia, Bombay and Potsdam, and by various pendulums at Nicolaiew, Catania, Ischia, Rome, Edinburgh and the Isle of Wight. The detailed records are given by Dr. Agamennone in the *Bollettino* (vol. iv. No. 4) of the Italian Seismological Society, and the same writer has investigated the velocity of the earth-waves in a paper read before the R. Accademia dei Lincei (*Rend.*, vol. vii. pp. 155–162). If the initial times be calculated from that given by the Batavia magnetograms, the velocities for both earthquakes would be 28 or 29 km. per sec., but there can be little doubt that the earlier vibrations are not shown on these curves, and that these estimates are consequently too great. Assuming, however, as is probable, that the magnetographs were not disturbed until the arrival of the long-period pulsations, Dr. Agamennone concludes that the first pulsations travelled with a velocity of $4\frac{1}{2}$–$6\frac{1}{2}$ km. per sec., and those which constituted the maximum phase with a velocity of $2\frac{1}{2}$–3 km. per sec.

THE Zoological Society have just issued the thirty-fourth volume of the *Zoological Record*, which contains a full account of the zoological literature of 1897, arranged in eighteen sections according to the usual plan of the work. The general editor of this most helpful publication is Dr. David Sharp, F.R.S. The various subjects have been undertaken by Mr. J. A. Thomson, Mr. R. Lydekker, F.R.S., Dr. R. Bowdler Sharpe, Mr. G. A. Boulenger, F.R.S., Mr. E. R. Sykes, Mr. E. A. Smith, Mr. G. C. Crick, Miss Florence Buchanan, Mr. A. W. Brown, Mr. F. A. Bather, and Dr. R. von Lendenfeld; while the general editor himself assumes the labour of the section relating to the Insecta, which occupies no less than 300 pages. The volume is prefaced by an alphabetical list of the abbreviations of the titles of publications used in the *Record*, which thus becomes a list of all the journals, *Transactions*, and other periodicals issued at the present time in which zoological papers are published. The number of these periodicals may be judged from the fact that the list contains 52 closely-printed pages. In this list the principal English libraries which contain copies of these periodicals are mentioned after every title. The volume concludes with an index to the names of new genera and subgenera proposed in 1897 and recorded in it, altogether 1574 in number. The corresponding total last year was 1541. No more useful piece of work could be done by the Zoological Society of London to facilitate the labours of working zoologists, and it is much to be regretted that all branches of science have not similar publications to assist the scientific "working man."

SEVERAL interesting papers on natural history topics appear in the *Transactions* of the Edinburgh Field Naturalists' and Microscopical Society (vol. iii. Part vii., 1898). Miss Sprague describes some common objects for microscopic study; Mr. W. Blacklock also deals with microscopy and some of its uses. The Rev. J. H. Lawrie gives an account of coral and coral-islands, with special reference to the New Hebrides group; and Mr. A. Murray contributes some interesting notes on the

life-history and habits of wasps. His paper contains an account of observations made by him of wasps in their natural state, extending over a number of years, and it thus possesses the merit of original work. In the course of the paper Mr. Murray remarks : " There is one thing which puzzles me much, namely, how a blackbird can stand at the side of a hanging wasps' nest, and tear it to pieces to devour the larva, and yet not be stung to death. The bird does not seem to be annoyed in any way, but if I venture to see what is going on, I am certain to be very much stung—I suppose, for not minding my own business." Among the other papers in the *Transactions* is one by Messrs. T. Scott and J. Lindsay, in which further results of the investigation of the micro-flora and micro-fauna of the Upper Elf Loch, Braids, are given. The paper illustrates the scientific benefits to be derived from a continuous examination of a particular loch or pond.

AT the Whitechapel Free Public Library and Museum, the following free science lectures (with lantern illustrations) have been arranged :—January 10, " How we digest our dinner," by Dr. E. H. Starling ; February 7, " A piece of limestone," by Mr. F. A. Bather ; March 7, " How animals warn their enemies and signal to their friends," by Cora B. Sanders.

WE have received the Christmas numbers of the *Gardeners' Magazine* and *Amateur Gardening*, both with very beautiful coloured illustrations, and a marvel of cheapness. Each periodical is also illustrated with photographs taken in well-known gardens at home and abroad, drawings of fruits and flowers, and others that will commend themselves to the gardener and horticulturist.

THE works from the library of the late Prof. Mariano de la Paz Graells are offered for sale by Herr Felix L. Dames, Berlin. A catalogue (No. 44) containing a list of works on natural history and zoology, vertebrates, anthropology, travels, and rare Spanish books on the chase and falconry, has just been issued. Lists of papers, &c., on invertebrates, botany, and entomology will be given in future catalogues.

IT will interest microscopists to know that Mr. Charles Baker, maker of optical and surgical instruments and accessories, proposes to commence a new department for lending microscopic specimens, much on the same lines as a lending library. The arrangement should be of service to many amateur microscopists, especially beginners and those living in districts where there are no microscopical clubs or societies.

THE *Agricultural Gazette of New South Wales* for September is largely occupied with an account of the different species or varieties of *Opuntia*, or prickly pear, that have been introduced into the Colony, and the various modes of exterminating them. So great a pest to the farmers has this plant become, that the Colonial Legislature passed, in 1896, a stringent Act imposing heavy penalties on the growth of it, or on failure to extirpate it on cultivated land.

MR. W. J. C. MILLER, who was for many years registrar of the General Medical Council, and had to resign his duties owing to a sudden breakdown, is, we are informed, now in a satisfactory state of health. In announcing his forthcoming work on "Nature Studies" (p. 155), he was referred to as the late Mr. Miller, and we are glad to be able to correct the wrong impression thus conveyed.

A BUNDLE of papers upon the methods and results of teaching speech and the knowledge of language to deaf-mutes has been received from the Volta Bureau, Washington, D.C. It may be remembered that this Bureau was founded in the year 1880 by Dr. Alexander Graham Bell, with the Volta prize of fifty thousand francs received by him for the invention of the telephone. It has for its objects the increase and diffusion of knowledge relating to the deaf, and performs most useful work in furtherance of them. The publications issued by the Bureau show that astonishing results are obtained by systematic instruction on sound principles.

THE *Journal of the Royal Microscopical Society* for December contains a continuation of Mr. Millett's report on the recent Foraminifera of the Malay Archipelago collected by Mr. Durrand, as well as the usual summary of recent researches in zoology, botany, and microscopy. In the latter department the President, Mr. Nelson, gives an interesting account of a binocular microscope designed and made by an amateur, and of an old microscope made by Mr. J. Cuff about the year 1760. This number also contains the very useful list of new terms in zoology and botany introduced during the year into scientific terminology.

FOR the purpose of understanding the effects produced on cultivation and hygiene by the variations of the weather and the changes in the composition of the atmospheric air, the Montsouris Observatory was charged to carry on experiments and investigate problems connected with the climate and hygiene of Paris. The work of the observatory is divided into three sections, which may be roughly described under the headings : physics and meteorology, chemistry, and micrography. Every year the observatory issues a small volume, "Annuaire de l'Observatoire Municipal de Paris," in which is embodied much valuable information based upon the researches and observations carried on under its direction. Containing, as it does, a mine of facts which should prove very useful to scientific workers, the volume for 1899, which includes an account of the work accomplished in 1897, will be welcomed by many.

THE *British Journal Photographic Almanac* has steadily increased in size for the past few years, and the new number for 1899 contains no less than 1508 pages ; this, of course, includes the host of advertisements, which by themselves are of interest to the photographer. Many of our readers are probably familiar with this annual publication, and will therefore know how difficult it is to make selections from the large amount of useful information given in it. We may say, with the editor, that the principal features of last year's volume have been repeated, and that all tables, formulæ, and other necessary facts for the photographer have been inserted and brought up to date. The volume contains, as usual, several specimens of reproduction processes, and illustrations of rapid shutter work, but they do not seem to be so numerous as in the previous publications. The Almanac should, however, be found in every studio, for the numerous facts contained in it will frequently be found of service.

THE compact little annual of the *Bureau des Longitudes* for 1899, published yearly by the National Convention to " propre à régler ceux de toute la Republique," is as interesting and complete as ever. It is unnecessary to refer to the detailed contents of the volume, but a statement of the alterations and additions that have been made in the present issue should be of interest. In the astronomical section the list of minor planets is brought up to September 13, 1898, and many details of these bodies, such as name, discoverer, date of discovery, duration of sidereal revolution, mean distance from sun, eccentricity and inclination are given. The table showing the elements of periodic comets has been revised, and a brief history is given of the comets which appeared in 1897. In the section devoted to geography and statistics, new values for the area of France, obtained from the Army Geographical Service, are inserted. M. Cornu has revised his article on electricity, and added a valuable note on electrical units as used in practice. The

articles included in the volume always give special interest to it; they are this year on the following subjects:—On sounding balloons, by M. Bouquet de la Grye; modern French geodesy by M. Bassot; on the large siderostat and telescope of 60 metres focal length and 1·25 metres aperture, which is being constructed by M. Gautier; and, lastly, on the work done at the Mont Blanc Observatory in 1898, by M. Janssen.

THE additions to the Zoological Society's Gardens during the past week include a Puma (*Felis concolor*) from Argentina, presented by Mr. T. S. Nicholson; a Red and Blue Macaw (*Ara macao*) from Central America, presented by Mr. H. Sneggitt; a Gannet (*Sula bassana*), European, presented by Mr. A. Trevor-Battye; a Greek Partridge (*Caccabis saxatilis*) from Greece, presented by Lieut. J. H. Mackenzie, R.N.R.; a Lapland Bunting (*Calcarius lapponica*), a Reed Bunting (*Emberiza schnoeiclus*) European, presented by Mr. F. Chatwin; two Black-winged Peafowl (*Pavo nigripennis*, ♂ ♀) from Cochin China, presented by Mrs. Johnes; a Hallowell's Tree Snake (*Dendraspis viridis*) from the Gold Coast, presented by Mr. J. W. Kaye; an Antillean Boa (*Boa diviniloque*) from the West Indies, three Horsfield's Tortoises (*Testudo horsfieldi*) from Central Asia, deposited; a Triton Cockatoo (*Cacatua triton*) from New Guinea; six Gadwalls (*Chaulelasmus streperus*) from Holland, purchased; three Rosy-faced Love-birds (*Agapornis roseicollis*), bred in the Gardens; an Urial (Wild Sheep (*Ovis vignei*, ♂) from Persia, received in exchange.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JANUARY 1899:—

January 2. Meteoric shower from Quadrans (Radiant 230° + 52°.)
2. 7h. 14m. Minimum of Algol (β Persei).
4. 15h. 38m. to 17h. 24m. Transit of Jupiter's Satellite III.
5. 10h. Venus at her greatest apparent brilliancy and a fine object in the morning sky. She rises about 3½ hours before the sun, and is situated 10 north of the red star Antares in Scorpio.
7. 17h. 3m. to 17h. 48m. The star 42 Libræ (mag. 5·2) occulted by the moon.
9. 19h. Mercury in conjunction with the moon (☿ 2° 56′ N.)
9. 10h. 38m. Partial eclipse of the sun visible at Greenwich.
11 14h. Mercury at his greatest elongation (23° 35′ W.), rising about 1¾ hour before the sun, and situated 10° east of Saturn, and 19° east of Venus.
11. 19h. 48m. Ingress of Jupiter's Satellite III.
15. Jupiter. Polar diameter 32″·8.
15. Venus. Diameter 35″·4. Illuminated portion of disc 0·332.
18. 12h. Mars in opposition to the sun.
18. Mars. Apparent diameter 14″·4.
19. 8h. 5m. to 9h. 14m. The star μ Arietis (mag. 5·8) occulted by the moon.
22. 15h. 33m. to 16h. 29m. The star 121 Tauri (mag. 5·4) occulted by the moon.
24. 17h. 32m. to 18h. 26m. The star 56 Geminorum (mag. 5·0) occulted by the moon.
25. 5h. 45m. Minimum of Algol (β Persei).
30. 13h. 39m. to 14h. 57m. The star B.A.C. 4006 (mag. 5·7) occulted by the moon.

It may be mentioned as a very unusual circumstance, that during the first half of January all the major planets of the solar system may be observed in the morning sky.

COMET CHASE.—The following is the ephemeris for comet Chase for the ensuing week. The comet is moving in the southern extremity of the constellation of Ursa Major, and lies a few degrees south of the star ξ Ursæ Majoris.

Berlin Mean Midnight.

1898–9.	R.A. (app.) h. m. s.	Decl (app.)	Br.
Dec. 30	11 2 24	+28 18·6	1·1
Jan. 1	3 40	28 39·6	
,, 3	4 49	29 1·1	1·1
,, 5	11 5 50	+29 23·5	

ARTIFICIAL PRODUCTION OF SUN-SPOTS.—In the *Archives des Sciences physiques et naturelles* (November) M. Th. Lullin describes some experiments he has been undertaking with regard to producing the forms of sun-spots artificially. Commencing with the now generally assumed hypothesis that sun-spots are caused by the downfall of cool matter from the higher regions of the solar atmosphere to the lower and more intensely heated gases, he has been investigating the behaviour of splashes of water on a viscous substance, such as barium sulphate placed on a glass plate. An examination of the illustrations which accompany his paper, shows that, even with these crude imitations of the real elements at work, very striking results can be obtained which have their counterparts in actual sun-spots. Thus the striated appearance radiating from the umbra is well obtained, while the appearance of bridges can be easily reproduced. In these experiments there seems every hope that by imitating the results of the falls of separate streams or series of drops simultaneously on to a surface of some liquid of less density, still greater approximation to the actual appearances of solar spots would be obtained.

THE HEAVENS AT A GLANCE.—For the last two years Mr. Mee has issued a small card which contained a large amount of useful information arranged in chronological order, showing the amateur at a glance the sequence of astronomical events of interest for the year. Unfortunately the information on this card was not clearly printed, but was simply a reproduction of the original handwriting of the compiler: on this account the card was not such a useful addition to an observatory as it might have been. The new issue for the year 1899 has, however, been altered in this respect, and it is well arranged and clearly printed. The constellations visible, the declination of the sun, the phases of the moon, those planets that are well placed for observation, are given for each month, together with the times of appearance of the most prominent meteor showers, maxima and minima of the principal variables, &c.

These are followed by notes on the sun, planets, eclipses, and others containing just that information that the amateur should find most useful: symbols and abbreviations have been used as little as possible. Equipped with this card, possessors of small telescopes have a useful and simple programme of the astronomical occurrences for the year 1899.

ARE MOLDAVITES OF CELESTIAL ORIGIN?—Herr Dr. Franz E. Suess, of Vienna, has had the opportunity of studying several hundreds of specimens of pieces of moldavite which had previously been found between "Trebitsch and Dukowan, near Mahrisch-Kroman." These moldavites, which have a bottle-green, glass appearance, and are inclined to be egg-shaped, were first discovered at the beginning of this century, and very much doubt has been cast on their origin. In the paper before us (*Kaiserliche Akad. d. Wiss in Wien*, November 17), Dr. Suess describes previous theories of origin suggested, and gives his own reasons for the opinion he has formed. A thorough examination of very many specimens has led him to believe that their surface forms can in no way be explained by weathering or collisions, but that these surface markings seem to be very closely related to the indentations of meteorites. All the surface markings on these moldavites can be explained on the assumption of the influence of an enormous air resistance. Dr. Suess then describes the differences in form of the surfaces he examined, and classifies them under different headings. In concluding his remarks, he suggests that the reason why the origin of these moldavites has not been previously attributed to the same as that of aerolites, can be accounted for only on the curious chemical nature of these bodies. Considering the comparative little knowledge we possess concerning the chemical nature of bodies of cosmical origin, we must conclude that we "must add to the known groups of aerolites a new group, namely moldavites."

It would be interesting to make a spectroscopic examination of some of these specimens, and compare their spectra with those of other meteorites that have been previously examined.

JUPITER AND HIS MARKINGS.

JUPITER is now coming into a favourable aspect in the morning hours. His position about ten degrees south of the equator will, however, be an unfortunate circumstance for European observers. To those, however, who can command an open southern sky, there will be plenty of opportunities for successful research; and, certainly, this magnificent planet deserves all the study that can be possibly devoted to him. In 1899 it is to be hoped that a great number of drawings will be made, and that the latitudes of the belts and spots will be micrometrically determined. We also require a fresh and extensive series of the times of transit of the principal light and dark markings, so that their longitudes and rate of drift relatively to the zero meridian may be ascertained. The latter element requires close attention at every opposition, as the velocities of the various currents are frequently changing, and it is possible they are regulated in definite cycles.

During the last opposition the planet received widespread notice from many observers, including Brenner, Fauth, Gledhill, Hough, MacEwen, Phillips, Comas Solá, Stanley Williams, myself and others. No very special phenomena were presented to arouse so much interest, but the disc was replete with a variety of interesting formations. The equatorial region exhibited an abundant series of dark and bright spots. These were moving more rapidly than similar and probably identical features last year, the difference of velocity being about 10 seconds. It will be important to determine whether a further acceleration of speed occurs in 1899. In 1897 the mean rotation of the equatorial current was 9h. 50m. 34·6s. according to Mr. Williams, while in 1898 the writer found it 9h. 50m. 23·6s.

In the north tropical zone there were several dark elongated spots visible during the last opposition. These completed a rotation in about $15\frac{1}{2}$ seconds less than the red spot. This latitude, about 15° N. of the equator, appears to be very prolific in the production of dark and light spots, which in certain cases remain visible over considerable intervals. During the past few years these markings have presented some difficulties as to their identification, for some of them appear to be subject to variations in form and tint, and perhaps to temporary obscuration. They also, during different oppositions, exhibit a variable rate of velocity. Thus in 1894-5 a very dark and definite spot was seen on the northern edge of the north temperate belt. In the next opposition two other spots, which were known as the "violin" and "garnet" spots, were displayed in the same latitude, though the north side of the belt seemed to have vanished. In 1897 no conspicuous spots were detected in this zone, but several were seen in 1898, and one of these may possibly have been identical with the chief spot of 1894, and with the violin spot of 1895-6, as the following comparison of longitudes and rotation periods, obtained at Bristol, will indicate:—

		Longitude. °	Rotation period. h. m. s.
Dark spot ...	1894 November 5 ..	239·1	9 55 37·8
	1895 May 9	226·3	
"Violin" spot	1895 September 26 ...	222·6	9 55 33·8
	1896 February 9 ...	201·1	
1896-7 Spot apparently invisible.			
Dark spot "A"	1898 March 23 ...	126·7	9 55 27·7
	July 4	94·7	

The decreasing longitude of the spot agrees fairly well, and the rapid increase of velocity is well marked along the series, but the evidence that the objects were identical is certainly not conclusive. If the spot was temporarily hidden in 1896-7, its rate was probably 9h. 55m. 30·7s. It is curious that in 1890 Prof. Barnard found the rate of a dark spot in same latitude 9h. 55m. 30·3s.; while in 1891 Prof. Hough derived a value of 9h. 55m. 27·4s. from a mean of two spots. From a comparison of a large number of rotation periods of this current at different times, it appears a probable inference that the time oscillates between 9h. 55m. 26s. and 9h. 55m. 41s. in a period of about seven years. This is somewhat doubtful, but the variation of rate seems well marked and to give evidence of regular periodicity. It will be especially interesting to redetermine the rotation period during 1899 if spots are still displayed in this latitude.

With reference to the red spot, I re-observed it on November 29 at 19h. 55m., when it was on the central meridian, and followed the zero meridian of System II. by about fifty-three minutes.

The question has often been asked as to whether the great red spot of modern times is identical with Cassini's spot of 1665 and following years? There seems a large amount of significant evidence to support the affirmative view. The observations spread over the 234 years, from Cassini's first observation to the present time, do not afford many connecting-links, but the probabilities are all on the side of identity.

Though the ancient object is generally called Cassini's spot, it was really discovered by Robert Hooke, with a telescope of twelve feet focus and two inches aperture, on 1664 May 9. He detected, "at about nine o'clock at night, a spot in the largest of the three obscure belts of Jupiter, and found that within two hours afterwards the said spot moved east to west about half the length of the diameter." To Hooke, therefore, belongs the credit of discovering this object, and the indication it afforded of fixing the exact time of rotation of the planet. But Cassini took the marking under his special charge, seeing, as he did, the important deductions to be made from it. Observing it frequently in the summer of 1665, he ascertained the rotation period as 9h. 56m. I have gone over many of Cassini's observations, and make the corrected period of rotation 9h. 55m. 47·5s. in 1665-1672. Cassini says he was assured of the preciseness of one mean revolution to one-eighth of a minute. On 1672 March 1, he saw the spot in transit on two occasions (viz. at 7.30 and 17.26), and announced to the French Academy of Sciences on the following day that the spot might be again seen in transit on March 3 at 9.8 p.m. The Academy thereupon deputed two of its more prominent members to verify Cassini's prediction. With this purpose in view, they repaired to the observatory, and, in company with Cassini, actually observed the spot return exactly as foretold by him.

The spot seen by Hooke and Cassini was about one-tenth of the apparent diameter of Jupiter; this would be about 9000 miles, and equivalent to the width of the spot in recent years. The oval shape it now presents may be due to the rapid rotatory motion of the sphere, which we know has the effect of spreading out objects in a longitudinal direction. Several new belts have been formed under the eyes of observers. But in the case of the red spot, its material may have been sufficiently solid to withstand the winding-out process beyond the elliptic form which became its permanent shape.

If the spot which Hooke saw on 1664 May 9, was the same as the relic of the red spot observed at Bristol on November 29 last, then in the interval of $85{,}670\frac{1}{2}$ days no less than 207,084 rotations have been performed, if we adopt the mean rate as 9h. 55m. 40s. during that long interval. It is quite possible to trace back the spot or its accompanying hollow in the great southern belt to 1831, and a further search amongst old drawings of Jupiter may take its history safely back to the time of Sir William Herschel and J. H. Schroeter. W. F. DENNING.

THE NEW LIVERPOOL MUSEUMS EXTENSION BUILDINGS.

THE present museums buildings were erected in 1860 by the late Sir W. Brown for the splendid natural history collections bequeathed to the City of Liverpool by the XIIIth Earl of Derby in 1851. These were so extensive that the accommodation they required necessitated the building of what was, at that time, one of the largest museums in England outside the Metropolis. Since that date the collections have been constantly added to, not so much by purchases, as by gifts—some of them of the highest value—from donors possessing an interest in natural science, and appreciating, in advance of their time, the importance of that subject as a means of education, with the result that, to-day, every available foot of space in the museums has long been occupied—every cellar even being stored to its utmost capacity—so that any intelligible arrangement of their contents has now become well-nigh impossible. Within the past decade, also, the change in the public attitude has been growing very rapidly towards an appreciation of museums as institutions of high educational value and importance. This is due, no doubt, to the rapid increase of scientific and technological knowledge, and to the advocacy of no one in Europe so specially as Sir William Flower, who, by his writings, and, perhaps, principally by the methods, inaugurated by him, of displaying and labelling the specimens in the Natural History Museum in South Kensington, has made manifest, not the

interest only, but the educational value of the study of natural objects. The Corporation of Liverpool has been one of the first to recognise this advance in opinion in raising the city's museum to the position of a first-class scientific institution, by voting the necessary funds for its proper support, and keeping the collections abreast of the stream of discovery.

The additions—chiefly by purchase—to both the Derby and Mayer Museums have been within the last three or four years so specially numerous that since 1893 it has been evident to the Museums Sub-Committee of the Libraries, Museums, and Art Committee of the Council that increased space was urgently necessary.

The Technical Instruction Sub-Committee then also found itself in the same position in regard to a central school to accommodate the more advanced classes, which were and are now being held in widely separated parts of the city, in buildings most of them ill adapted for teaching purposes.

A special Sub-Committee was therefore constituted in December 1894, empowered to take immediate steps for the extension of the museums, and for providing suitable accommodation for the Liverpool School of Science, Technology, and Art The credit of overcoming the difficulties which beset the initiation of so large a scheme, and of arranging the preliminaries, is chiefly due to Sir William Forwood.

The present museum buildings stand on a rocky plateau sloping abruptly towards the west. By excavating this slope, consisting of Permian rock, down to the level of Byrom Street, sufficient accommodation, three stories in height, could be provided for the Technical Schools, while the museum galleries could be carried forward, on their present level, over the schools. The Technical Schools will thus be distinct and entirely isolated, and have their own entrance in Byrom Street.

This being so, designs with estimates for a building—whose requirements were sketched out by the Director of Technical Instruction and the Director of Museums respectively—were invited from a selected list of architects of eminence in England. In the summer of 1896 the designs of Mr. Edward William Mountford, of London, were awarded the first premium. The handsome and stately building so designed, which is represented in the accompanying illustration, will be 90 feet above the level of Byrom Street, and measuring from north to south 162 feet, and from east to west 190 feet, occupying an area of 27,000 square feet. The galleries of the museum will run in continuity with those in the existing building, and will be undivided in any part of their course by walls or partitions. They will be of horse-shoe shape, and 420 feet in length, 33 feet in breadth; the lower—to contain the Invertebrates—19 feet in height, while the upper—for the Vertebrates—will be 27 feet. The lower floors will be lighted from the side, and the upper from the roof. New and well-appointed laboratories—which, when the first building was erected, had been entirely overlooked, or, at that date, considered quite unnecessary adjuncts to a museum—for the director and his assistants, are also to be provided, as well as new administrative offices.

The new buildings will be of brick, faced with Stancliffe stone from the quarries at Darley Dale, in Derbyshire, the same which furnished the material of which St. George's Hall is built. They will be the largest built by the Corporation of Liverpool for fifty years, and the largest since the erection of St. George's Hall, and, next to it, the largest building in the city. The front to Byrom Street rises from the very edge of the original "Pool," and is close to the site where the old bridge connected Liverpool with the heath.

The ventilation and heating of the buildings will be carried out on a system which provides upwards of four miles of three-inch pipes, discharging into every room purified and warmed air to the amount of 8,000,000 cubic feet per hour. The stairs are of stone, the floors of concrete, and the roof chiefly of steel, so as to reduce the chance of fire to a minimum; in case of which, however, an emergency staircase will provide exit for visitors in the museum.

The New Central Technical Schools and Museums Extension Buildings, Liverpool.

The work of excavating the rock, of which the slope extending west of the present museums is composed, was commenced on November 1, 1897.

On July 1 last the foundation stone was formally, and very appropriately, laid by Alderman Sir William Bower Forwood, who has for many years been Chairman of the Standing Committee in charge of the libraries, museums, and art gallery, and to whose energy and powerful advocacy, not only the approaching realisation of this much-needed extension of the two departments of technical instruction and the museums are, in a very special manner, due, but also the large increase and development of the two other departments under his chairmanship—the libraries and the art gallery.

On the stone being "well and truly laid," Sir William Forwood gave an interesting address, in which he said the City Council, by that day's proceedings, announced to Liverpool that they believed that technical instruction had come to stay with them; that it was now part of the life of the people; and that it was worthy of that magnificent home. This building

would complete what he believed would be the most unique group of buildings in the world. It was intended for the higher technical education—for educating the captains of labour, and not merely the artisans, in a way that would enable them to meet the competition of Germany. The Germans had had these superior schools for years, and had been turning out a large number of expert and scientific men such as did not exist in England. They, however, hoped to make them exist in Liverpool, and he also hoped that this building would enable them to start in Liverpool many new industries that would give employment to the surplus population, and especially to females.

Speaking of the accommodation which would be afforded to the museum, Sir William reminded them that it had been founded by a bequest by the XIIIth Earl of Derby, some sixty years ago, and had been strengthened year by year by purchase. They were able to display only about one-half of their collections, and even that was so crowded that it was impossible to attempt any classification. This building would enable them to unpack and arrange scientifically the whole of their treasures, and in a short time they would have a museum unequalled out of London. When visiting Rome, Florence, Venice, and Athens, they were attracted there, not by what the Cæsars and Doges had done, not by the spoils of war, but by the monuments of art and the stores of literature which were left behind in these cities. In the same way he hoped that these buildings would tell future generations that, while they had been strenuously engaged in commerce, they had not been forgetful of the intellectual welfare of the citizens, knowing that by doing so they were promoting public morality as well as the material prosperity of the people.

ECONOMIC BOTANY IN NYASALAND.

THE following interesting notes on some of the exotic economic trees and shrubs cultivated in the Residency Grounds, Zomba, British Central Africa, are given by Mr. John Mahon, Government Botanist, in the annual report on the Protectorate for the year 1897-98 (C-9048). Accompanying the notes in the report is a complete list of exotic trees and shrubs growing at Zomba.

The collection of exotic plants grown at Zomba possessing economic value is not at present very extensive, but it is being steadily added to. The Coffee-disease Regulations in force prevent plants or seeds being imported from several tropical centres where we could obtain many valuable things, and the long journey from England hinders us from obtaining plants in Wardian cases from the Kew establishment or any of the large nurseries, except the consignment is taken in hand by some officer of the Protectorate, or the like, who is making the voyage out and sees it safely through. The authorities at Kew, having such unusual opportunities for distributing seeds, frequently forward valuable material to us, and many of the items mentioned emanated from Kew, either as seeds or plants. The list forms an interesting record of the cultural possibilities in the climate of the Shiré Highlands. There are but few countries where one can see such an essentially cool and northern type of vegetation as the Lawson cypress (which bears seed in enormous quantities) growing alongside such an essentially tropical type as the gutta-percha of Malaya (*Dichopsis gutta*). Although it is true the latter does not reach its proper degree of development, yet it is perfectly healthy, and it points to the fact that in the lower and warmer region on the Shiré River it would be a valuable culture.

Many of the items mentioned are only represented by one plant, and many of them are not old enough to have reached the fruiting period. Some of the introductions grow with surprising vigour. For instance, eucalyptus, the seeds of which were sown about six years ago, are now over sixty feet high, and would yield very capable timber if required. The well-known blue gum is not, however, a success here, but it seldom is in these latitudes below the 5000 feet level. Still there remains numerous equally good, and even better, members of this useful genus which we can cultivate with success.

Mauritius hemp (*Furcræa gigantea*) and sisal hemp (*Agave rigida*, var. *sisalana*) grow with great freedom, and while it would scarcely pay to cultivate these valuable fibres at present for the European market, yet if any textile industries arise locally there can soon be plenty of raw material at hand to supply them.

Seeds of the celebrated China grass (*Boehmeria nivea*), a fibre very much in demand now, have been ordered, and it is intended to demonstrate that it is a profitable culture that might be grown in Nyasaland with the object of exportation to the European markets. Arnatto (*Bixa orellana*) fruits with great profusion; the seeds are used in the arts as a dye, and as colouring agent for butter; the supply at present, however, from Colonies like the West African, exceeds the demand.

Fruits are a very important culture in all tropical countries, and the indications point to the Shiré Highlands being suitable for raising the fruits of many diverse countries. The mango (*Mangifera indica*) grows with much luxuriance, but as all the existing plants at Zomba have been introduced recently they have not yet reached the fruiting stage. One tree is expected to yield some fruit this year. The same applies to oranges, avocado pear, and guavas, although at present one tree of the latter is maturing fruits. (On the Buchanan estate, close to the Residency, oranges bear with great profusion, and up till recently peaches were a great success there.) The granadilla (*Passiflora quadrangularis*) fruits freely, and the fig (*Ficus carica*) seems quite at home. The grape vine grows well, and is a recent introduction; we expect to see it fruiting next year. Bananas, it need hardly be remarked, bear with great abundance. Up to the present this is practically the only fruit the native grows.

Exotic timber trees are very promising. The red cedar (*Juniperus virginiana*) and West Indian cedar (*Cedrela odorata*) do extremely well, and are important in view of the expected development of the tobacco industry, as they supply material from which first-rate cigar boxes can be manufactured. Kauri pine (*Dammara Australis*), a timber of great value and utility, promises to become a great success here, for seedlings planted a year ago have reached over three feet in height. Mahogany does very well. The good offices of Kew have been requested in obtaining for us a large quantity of seeds in order that we can grow it on a considerable scale and distribute it over the Protectorate. The splendid Mlanje cedar (*Widdringtonia whytei*) grows with unexampled vigour at Zomba, which is at least 3000 feet lower than its native habitat. It is very interesting to find it doing so well here, and points to the fact that in time the hills of Nyasaland above the 3000 feet level can be successfully forested with this excellent timber. Seeds from the trees at Mlanje have been widely distributed amongst Government officers, missionaries, and planters in the Protectorate, as well as to various parts of Southern Africa.

Perhaps enough has been said to indicate the diversity of cultures possible in the Protectorate. The Botanical Department at Zomba is very young yet, but endeavours are being made to render it of service to the country. As it is, it can demonstrate that many plants of commercial importance find a suitable home in the soil and climate of Nyasaland.

THE IRON ORE DEPOSITS OF NORTHERN SWEDEN.

OF the excursions in connection with the last meeting of the Iron and Steel Institute in Sweden, none was of greater interest than the visit to the vast mountains of iron ore at Kiirunavaara and Luossavaara within the Arctic Circle. The party of members invited by the owners of the mines was necessarily limited, and the journey was long and arduous. After travelling 820 miles by railway, the party proceeded in carriages for forty miles over a loose shingle road, then for forty miles more up the Kalix river in boats poled against the stream, and lastly for ten miles on foot. The visit to the mines was made under the guidance of Mr. H. Lundbohm, of the Geological Survey of Sweden, who contributed to the meeting an interesting paper describing the deposits. From this the following details are derived:—

The character of the country is very remarkable. The Kiirunavaara mountain consists of a steep ridge extending for about 2½ miles, divided into a series of peaks varying in height from 270 to 2450 feet above the lake Luossajärvi, which separates it from the gently sloping conically shaped Luossavaara. On the tops of these mountains the ore lies almost entirely uncovered by soil; on the sides it is covered by morainic material and beds of gravel and sand; while the mountains are

surrounded by extensive morasses. The ore occurs in bed-like masses in porphyries of varying character and composition. The total length of the Kiirunavaara ore body is 15,500 feet. The width is usually 330 feet, but in one place it is as much as 840 feet. The dip varies from 45° to 60°. It is estimated that the quantity of ore available above the level of the lake at Kiirunavaara is 215,000,000 tons, and at Luossavaara 18,000,000 tons.

The Kiirunavaara ores differ widely from most Swedish ores. They are unusually hard and compact, and remarkably free from all foreign minerals except apatite. That mineral is, however, exceedingly abundant. Analyses show that ores occur with less than 0·05 per cent. and from 0·05 to 0·1 per cent. of phosphorus in such quantities that they can be mined separately. The bulk of the ore, however, contains 1 to 4 per cent. of phosphorus. The percentage of sulphur is usually 0·05, and sometimes less than 0·02. Titanium varies from 0·32 to 0·95 per cent., and manganese does not exceed 0·32 per cent. The great bulk of the Luossavaara ore is comparatively low in phosphorus, and much of it appears to be well adapted for the acid Bessemer process.

No serious attempt was made to work these deposits before 1880, when a concession was granted for the construction of a railway from Luleå to the Ofoten fjord; but the concession was withdrawn after the railway had been completed from Luleå to the iron mines at Gellivare. This year, however, the Swedish parliament authorised the construction of a railway from Gellivare, past the Kiirunavaara and Luossavaara deposits, to the Norwegian frontier; and the Norwegian parliament has authorised its being continued to Victoria Harbour, on the Ofoten fjord, a port free from ice throughout the year. The distances from the iron ore deposits along the projected line of railway are—to Gellivare, 63 miles; to Luleå, 182 miles; to the Norwegian frontier, 79 miles; and to Victoria Harbour, 120 miles. Within a short period these vast supplies of iron ore will thus be rendered available, and British ironmasters will have within easy reach sufficient ore to last for many generations to come.

ELECTRICAL STAGE APPLIANCES.

THE proposed application of electrical power for mounting plays at Drury Lane, on the lines advocated by Mr. Edwin O. Sachs, has now taken a tangible form in the completion of the first section of the stage installation in time for the impending pantomime.

Mr. Sach's present work refers principally to the stage floor and its movability in sections above and below the footlights. The total area now already movable by mechanical power exceeds 1200 square feet.

The electrical appliances just completed take the form of so-called "bridges," each working independently. Each individual section measures 40 feet by 7 feet, and weighs about 6 tons, of which about 4 tons are counterbalanced. They can travel about 20 feet vertically.

The motive power is from the ordinary electric supply mains over a four-pole motor, developing 7½ horse-power at 520 revolutions per minute. The "bridges" are suspended from cables, and these, working over the motor, allow the former to be raised with the necessary live load at rates varying from 6 feet to 20 feet per minute.

Every possible safeguard has been taken against accident, the "bridges" themselves being so constructed that in the event of derangement of current the appliances can be worked by hand gear. Automatic switches are provided so as not to be entirely dependent on the attendants, and automatic catches will work in case of rope-breaking. Special locking-gear has been installed to hold the "bridges" stationary at certain points, such as stage level, and a very large factor of safety has been allowed in apportioning the strengths and weights in the various parts of the mechanism, having special regard to the ever-increasing scenic requirements under Mr. Arthur Collins's able management.

As regards the economic aspect of the electrical installation, the initial outlay on the system adopted is about half that of continental hydraulic work. The maintenance is minimal, whilst the actual working only costs a few pence per performance. The saving in manual labour on the stage is very considerable, whilst the hygiene of the theatre is materially raised by the absence of woodwork.

METALLIC ALLOYS AND THE THEORY OF SOLUTION.[1]

THE term alloy in its technical sense is used to indicate a solid mixture of two or more metals. The earlier investigators in this field, such as Matthiesen, Richie and many others, worked mainly with solid alloys, and they endeavoured to investigate the change in properties of the alloy, such as conductivity for heat and electricity, malleability, ductility and the like, with successive small changes in composition.

This method, although well adapted to bring out properties of alloys suitable for use in the arts, has not till recently shed much light on the real constitution of this interesting group of substances. Chemists have neglected the subject because the ordinary processes by which they attack problems fail them when dealing with alloys, on account of their opacity, want of volatility and power of being separated from one another by crystallisation. Another difficulty arises from the fact that the resulting alloy has usually the same colour as the metals from which it is produced, except in a few cases, such as the rich purple alloy of gold and aluminium investigated by Prof. Roberts-Austen, and the alloy of zinc and silver noticed by Matthiesen and investigated by Neville and Heycock, which has the property of taking a superficial rose tint when heated and suddenly cooled.

During the past twelve years considerable advance has been made in the study of alloys by investigating some of their properties whilst in the liquid state, such as the temperature at which solidification commences; it is convenient to term this temperature the freezing point. Le Chatelier, Roberts-Austen, Neville, myself and others have all worked in this way. The result of this work may be very briefly stated as follows.

Solutions of metals in one another obey the same laws that regulate the behaviour of solutions of such substances as sugar in water. For example, if we take solutions of sugar of different concentrations, but not exceeding 3 or 4 per cent., we find that within these limits the lowering of the freezing point is nearly proportional to the concentration. Exactly in the same way, if we add to a quantity of molten sodium (freezing point 97° C.) some gold, we find the gold dissolves much in the same way that sugar dissolves in water. On determining the freezing point of the alloy we find that it is lowered in direct proportion to the weight of gold added, notwithstanding the fact that pure gold by itself melts at a temperature of 1060° C. It is remarkable that the effect of increasing the quantity of gold in the alloy continues to depress the freezing point of the sodium, until the alloy contains more than 20 per cent. of gold when the minimum freezing temperature 81·9° C. (eutect temperature) is reached. The case of gold dissolving in sodium may be taken as a very general one, for a large number of pairs of metals have been examined, and with but few exceptions, such as antimony dissolved in bismuth, the effect is almost always to produce a lowering of the freezing point of the solvent metal. By the solvent metal we generally mean the metal which is present in the largest quantity.

A second point in which metallic alloys resemble ordinary solutions is in the fact that the depression of the freezing point is inversely proportional to the molecular weight of the dissolved substance. Thus, if we dissolve 342 grams (molecular weight in grams) of cane sugar in 10 litres of water, and determine the freezing point of the solution, it is found to be depressed a definite number of degrees below that of pure water. But the same depression of the freezing point is produced by the solution of 126 grams of crystallised oxalic acid, or only 32 grams of formic acid, in 10 litres of water.[2] Alloys again appear to obey the same law; thus it is found that if we dissolve 197 grams of gold, or 112 grams of cadmium, or 39 grams of potassium, respectively, in a constant weight of sodium, the freezing point of the sodium will be lowered by almost the same number of degrees in each case. Now the numbers 197, 112 and 39 are the atomic weights of the metals, and it can be shown that these numbers are also probably the molecular weights of these elements. Hence we conclude that metals dissolved in each other obey the same laws as ordinary solutions.

The above facts for the behaviour of solutions of substances

[1] A discourse delivered at the Royal Institution by Mr. Charles T. Heycock, F.R.S.

[2] Although water is used as a solvent by way of illustration in these cases, it should be stated that it is by no means a suitable liquid for such experiments, owing to the changes it brings about in the substances dissolved. In making such experiments it is far preferable to use benzene or acetic acid as a solvent.

in water and organic liquids have been gradually accumulated by the work of Blagden, Rüdorff, Coppet and Raoult, extending from about 1780 to the present time, but no general explanation of them was brought forward until Van 't Hoff advanced the remarkable theory that a dissolved substance was in a condition somewhat analogous to that of a gas, the solvent substance serving the part of the vessel in which the gas is confined, but also exerting other effects.

He further gave strong reasons for believing that substances in dilute solution obeyed the same laws that gases do—*i.e.* the laws of Boyle and Charles for temperature and pressure. Several other theories of solution, besides what may be termed the gaseous theory, have been proposed. Notwithstanding that some weighty objections can be urged against this theory, it is remarkable that we can by aid of it predict the numerical values for the fall of the freezing point of different solvents produced by the solution of other substances, provided that we know the latent heat of fusion of the solvent.

On applying the same reasoning to alloys, we find that the theory holds good, as the table below shows.[1] We see from

Observed Depression in the Freezing Point of a Solvent Metal, caused by the Addition of One Atomic per cent. of a Second Metal.

Solvent		Tin	Bismuth	Cadmium	Lead	Zinc
Depression calculated on theory of Van 't Hoff		3·0° C.	2·08° C.	4·5° C.	6·5° C.	5·11° C.
Metal dissolved	At. Wt					
Sodium ...	23	2·8	2·0	4·5	1·2	—
Copper ...	63	2·9	1·2	3·6	6·3	1 5 (rise)
Silver ...	108	2·9	2·0	10·8 (rise)	6·6	5·15 (rise)
Platinum ...	195	—	2·1	4·5	6·4	—
Gold ...	197	2·9	2·1	1·6	6·4	3·4 (rise)
Bismuth ...	209	2·4	—	4·5	3·0	5·1

this table that in no cases are the observed depressions of the freezing points greater than those calculated from the theory, but in many cases they fall below this quantity; this latter fact admits of explanation.

On the theory of Van 't Hoff it is necessary that when a solution begins to freeze the pure solvent should separate out first. This admits, in case of aqueous solutions, of simple proof; for if we take a dilute solution of potassium of permanganate and make it freeze slowly, we find that pure colourless ice separates out on the walls of the vessel, whilst the purple permanganate is concentrated towards the centre. This experiment led Neville and myself to try if a similar state of things could be shown for metallic alloys.

We have great pleasure in bringing before the Royal Institution this evening the first announcement of the results we have obtained. For this purpose we took two metals, gold and sodium, the former being very opaque to X-rays, whilst the latter is very transparent to them. A quantity of sodium was melted in a tube, and gold dissolved in it to the extent of about ten per cent. The alloy was then allowed to cool extremely slowly, and sections (about ⅛ inch thick) were cut from different parts of the solid alloy and placed between thin plates of aluminium to protect them from the air. These sections were then placed on a photographic plate, enclosed in a light tight bag, and exposed to the action of the X-rays. On developing the plate we found a complete picture of the inside of the alloy. Positives obtained from these negatives are thrown upon the screen. The sodium is seen to have crystallised out in plates, as is evident from its transparency, whilst the opaque gold is seen to have become concentrated in the mother liquor between these plates, where it finally solidified along with some of the sodium.

Very similar results are produced with other pairs of metals, such as aluminium and gold and aluminium and copper. Behrens, Roberts-Austen, Osmond and others have examined alloys, after superficial etching, with high microscopic powers, and they find a similar separation of the constituents.

We thus see that solution of metals in one another follows extremely closely the same laws that regulate solutions with which we are ordinarily familiar. I should like to state here that the matter of this lecture is largely drawn from the work carried out by Mr. Neville, F.R.S., and myself during the past six years.

[1] For the nature of this calculation, *vide* Heycock and Neville, *Chem. Soc. Jour.*, vol. lvii. p. 339. Also Neville, *Science Progress*, October 1895.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The electors to the Linacre Professorship of Comparative Anatomy will proceed to an election in the course of Hilary Term, and candidates are desired to send in their names to the Registrar of the University not later than January 31, 1899. The Board of Electors consists of the Visitor of Merton College (the Archbishop of Canterbury), the Presidents of the College of Physicians and the College of Surgeons, the Waynflete Professor of Physiology, the Regius Professor of Medicine, an elector appointed to represent Merton College, and an elector appointed to represent the Hebdomadal Council. The Hon. G. C. Brodrick, Warden of Merton, has been appointed by Merton College, and the Dean of Christchurch by the Hebdomadal Council.

The electors to the Sedleian Professorship of Natural Philosophy, vacant by the resignation of Prof. Price, will also proceed to an election in the course of Hilary Term, and names of candidates are to be sent in not later than January 31. The Board of Electors consists of the Vice-Chancellor, the President of the Royal Society, the Provost of Queen's College, the Professor of Experimental Philosophy, Savilian Professor of Geometry, an elector appointed to represent Queen's College, and an elector appointed to represent the Hebdomadal Council. Prof. Elliot and Prof. Rücker have been chosen as the last-mentioned electors.

THE Calendar of University College, London, for the session 1898–99, has just been received. The purpose of the College, as expressed in the Act of 1869, whereby the College was re-incorporated with additional powers, and divested of its proprietary character, is "to afford at a moderate expense the means of education in literature, science, and the fine arts, and in the knowledge required for admission to the medical and legal professions, and in particular for so affording the means of obtaining the education required for the purpose of taking the degrees now or hereafter granted by the University of London." During last session the following new departments were created: Laboratory of Experimental Psychology, Pender Chair of Electrical Engineering, the Edwin Chadwick Chair of Municipal Engineering. It is interesting to note that in the department of applied mathematics, Prof. Pearson gives, in the place of advanced class examinations, subjects for dissertations referring to the mathematical theory of statistics.

MR. W. C. MCDONALD's benefactions to the McGill University, Montreal, have often been the subjects of notes in these columns, and last week we recorded that he had received the honour of a knighthood in recognition of his gifts to philanthropical and educational objects in Canada. Mr. McDonald's princely gifts to the McGill University include 20,000 dollars to the Workman endowment for mechanical engineering; the erection of the W. C. McDonald engineering building, valued, with its equipment, at 350,000 dollars, and an endowment for its maintenance; the endowment of the chair of electrical engineering with the sum of 40,000 dollars; the erection and endowment of the physics building, valued at 300,000 dollars, and two chairs of physics with endowments amounting to 90,000 dollars; the endowment of the faculty of law with 150,000 dollars; the endowment and equipment of the chair of architecture; a further sum of 150,000 dollars for the maintenance of the engineering building; 50,000 dollars towards the endowment of the pension fund; and the erection of a new building for the Department of Chemistry, Mining, and Agriculture, at a cost of 500,000 dollars, making the total amount contributed to the institution upwards of 1,600,000 dollars.

THE Executive Committee of the Central Welsh Board have unanimously passed the following resolutions, among others, referring to the Board of Education Bill, and have forwarded copies to the Education Department and the Charity Commission, with an intimation that they will be brought before the

Central Board at their half-yearly meeting in April next. "That Clause 1 (2) of the Bill should be amended by omitting the words 'one other person,' in order to insert the words 'two other persons, one of whom shall be a person well acquainted with the conditions of Wales and the wants of the people.'" "That considerable difficulty might arise in the future from the apparently concurrent jurisdiction of the Board of Education and the Charity Commission foreshadowed in Clause 2 (2) and (3), and that it is important therefore that the Bill should be so amended as to provide for a completer fusion of these two bodies." "That the Bill should be so amended as to indicate clearly that there will be no interference with the present organisation of intermediate and technical education in Wales and Monmouthshire under the Welsh Act, and that provision should be made for preserving to the Central Welsh Board the functions exercised by it under its scheme, and under the Treasury regulations already in force, for the inspection and examination of schools in the Principality." "That the Central Welsh Board might properly be regarded as a Consultative Committee, to which matters specially connected with Welsh education might be referred by the Board of Education for consideration and report."

SCIENTIFIC SERIALS.

American Journal of Science, December.—Another episode in the history of Niagara Falls, by J. W. Spencer. The first episode of the river was characterised by a cascade comparable in size to the American Falls, draining the Erie basin alone. The commencement of the second episode was marked by an increase in the volume of water, owing to the drainage of all the upper lakes being turned into the Niagara. Subsequently the fall was increased from 200 to 420 feet. Instead of continuing until reduced to its present height of 326 feet, the author now believes that it was reduced to a lower amount, 250 feet, and subsequently increased. This additional episode accounts more fully for the narrows of the gauge than any previous explanation. The age of the Falls will probably come out a little different from 32,000 years, but their fate will be the same. They will disappear by the lakes being drained into the Mississippi basin by way of Chicago.—An apparatus for measuring very high pressures, by A. de Forest Palmer, jun. The pressure in a Bessemer steel cylinder filled with heavy oil compressed by a tinned-steel screw is measured by a thread of mercury in a capillary tube whose resistance alters with the pressure in a manner previously determined by the author. Pressures upwards of 4000 atmospheres may be thus measured.—The application of iodine in the analysis of alkalies and acids, by C. F. Walker and D. H. M. Gillespie. The reaction between iodine and hydroxides of the alkalies and alkaline earths in hot solution is regular and complete under analytical conditions, not being appreciably affected by the mass action of considerable excesses of iodine. The reaction is best applied in analysis by titrating the alkali with an excess of iodine, removing this excess by boiling, and estimating the iodine in the residue.—Some new tertiary horizons discovered near Punta Arenas, Chile, by A. E. Ortmann. These beds, examined by Mr. J. B. Hatcher, represent two new horizons different from and older than the tertiary beds known as Patagonian, containing a marine fauna completely new to science.—A biotite-tinguaite dike from Manchester-by-the-Sea, Essex Co., Mass., by A. S. Eakle. This dike cuts through the augite-syenite of Gales rock near Manchester. It is six inches wide, and exposed for twenty feet. It is very difficult of access, and is only exposed at low water. The rock has a greenish-grey colour and a slightly greasy lustre, like tinguaites and rocks rich in nepheline. Small phenocrysts of felspar are visible in the somewhat compact ground mass, and also much magnetite, mixed with biotite, occurs in brownish-black patches, giving the rock a mottled appearance.

Wiedemann's Annalen der Physik und Chemie, No. 12.—Genesis of the electric spark, by B. Walter. The author mounts a long sensitive plate on a little car moving on rails and driven by a falling weight. The discharge from an induction coil is so timed that at least two sparks are recorded. The negatives show that each spark consists of several successive discharges in the same direction, at intervals of $2 \cdot 7 \times 10^{-4}$ secs. The spark is invariably preceded by brush discharges, and in places where the spark is bent, a small brush-like appendage appears, showing that the spark changed its direction in consequence of too large a resistance.—Genesis of the point discharge, by E. Warburg. When a needle-point is mounted in the centre of a metallic sphere and charged to a certain minimum potential, a continuous discharge passes from the point to the sphere. The author finds that the discharge sets in about 0·007 seconds after the potential has attained the proper value.—Properties of the stratified brush discharge in the open air, by M. Toepler. When the current intensity of an influence machine discharge is raised from zero to a high value, the discharge, at first an ordinary brush discharge, takes the form of sparks, and is eventually converted into a stratified "brush light arc," showing white kathode light, scarlet positive light, and anode glow. This is another proof of the essential identity of open-air and vacuum discharges. If the gap is very small, only the spark discharge can be produced.—Tuning-plates as a substitute for tuning-forks at high pitches, by F. Melde. Small square Chladni plates, say 5 cm. wide and 0·5 cm. thick, give high notes whose pitches can be safely calculated from their dimensions. They can also be experimentally determined by the author's resonance method, being made to transfer their vibrations to a rod whose length is adjusted until distinct nodes are formed, made visible by sound. Notes of pitches up to 30,000, and quite inaudible to most ears, can thus be produced and studied.

The Quarterly Journal of Microscopical Science (November) contains papers on the development of the pig during the first ten days, the structure of the mammalian gastric glands, certain green (chlorophylloid) pigments in invertebrates, a larva in the metanauplius stage, and the nephridia of the Polychæta (Part ii.).

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 19.—"'Nitragin' and the Nodules of Leguminous Plants." By Maria Dawson, B.Sc. (London and Wales.) Communicated by Prof. H. Marshall Ward, F.R.S.

A study of the nodules found upon the roots of leguminous plants has led the author to an unhesitating confirmation of the parasitic nature of both the filaments and the bacteroids contained in these organs. The filaments, it was found, have no such constant relation to the nucleus of the cells, as was represented by Beyerinck in 1888. By plasmolysis of the root-hairs, the infection tube is shown to have grown into the hair, and not to correspond with the primordial utricle of the hair, a result which proves that Frank was mistaken in regarding the tube as formed from the contents of the hair mingled with fungal protoplasm. By staining with aniline blue and orseillin these tubes and the filaments in the cells were shown to consist of strands of straight rodlets, lying parallel to the longer axis of the filament, and embedded in a colourless matrix. This matrix does not consist of cellulose, chitin, or any form of mucilage. The swellings upon the filaments occur at places where the rodlets have become heaped up, and at such places the filaments eventually burst, liberating the rodlets, whilst they themselves remain as pointed portions, directed towards each other in the cells. After liberation from the filaments, the rodlets become transformed into X, V, and Y-shaped bacteroids. This variety of shape does not occur when these organisms are cultivated outside the plant on a solid medium, but in liquid pea extract, the change from straight rodlets to "bacteroids" occurs in a few days. By cultivating these organisms in drop cultures under constant observation with high powers, these rodlets are seen to multiply by division into equal, or sometimes slightly unequal, halves. By this method the author hopes also to determine whether the change in shape arises from fusion of two or more individuals or by branching. Their multiplication by division leads to the conclusion that these organisms are members of the Schizomycetes; whether or not they are true bacteria must, however, still be undecided until the final stage in their life-history has been fully followed.

The X, V, or Y-shaped bacteroid, when once formed appears to be incapable of further growth. These organisms are aerobic in character, their power of fixing atmospheric nitrogen is to be tested in connection with their growth on silicic acid gelatin.

Commercial "Nitragin" consists of minute micrococcus-like bodies, all straight and immobile. They multiply rapidly on gelatin media, and in pea extract become converted into "bacteroids" as well as straight rods. Nitragin does consist of the tubercle organism, and as a result of the inoculation of either seeds or soil with it, tubercle formation takes place. Crossing of kinds supplied for different genera and species is quite successful within the tribe Vicieæ. In order to test the possibility and conditions of direct infection of the roots, seedling peas, starting both before and after germination, were grown in sterile tubes, by which means the whole plant was kept under control. This method showed that direct infection of quite young radicles is tolerably certain, also of older roots, provided the conditions under which germination occurred are maintained after infection.

In order to secure infection it is not necessary that the organism should pass through the soil, and the age of the root-hair at the time of infection seems to be without effect upon the result. An accumulation of CO_2 round the roots is not the cause of failure in direct infection.

The addition of nitragin to soils rich in nitrates appears to be inadvisable, but a supply of it to soil poor in nitrates results in an increased yield, though better results are obtained if instead of nitragin, nitrates be added to the soil.

Royal Meteorological Society, December 21.—Mr. F. C. Bayard, President, in the chair.—Captain A. Carpenter, R.N., gave an account of the hurricane which caused so much devastation in the West Indies in September last. The cyclone, passing eighteen miles south of Barbados, swept over the southern half of St. Vincent Island, then took a north-west direction towards Aves Island, its rate of progression being about seven and a half miles per hour. From here it pursued a northerly course for 450 miles, passing between Puerto Rico and the Windward Islands. It then swerved to the north-west for 600 miles, when it re-curved to the north-east. Its diameter was eighty miles as it approached Barbados, and 170 miles after leaving St. Vincent. The actual storm-centre (in which the force of the wind greatly increased) was only thirty-five miles in diameter until St. Vincent was passed, but after that the strength of the wind extended to 170 miles from its centre. The diameter of the calm vortex, or "eye" of the storm, was not less than four miles. The storm was accompanied by very heavy rainfall, the amount at St. Vincent being about 14 inches in the twenty-four hours ending at 9 a.m. on the 12th. The barometer at the Botanic Gardens, Kingstown, on the 11th, fell from 29·539 inches at 10 a.m., to 28·509 inches at 11.40 a.m., a fall of 1·03 inches in 1 hour 40 minutes. In Barbados 11,400 houses were swept away or blown down, and 115 lives were lost; and in St. Vincent 6000 houses were blown down or damaged beyond repair, and 200 lives lost.—Mr. W. H. Dines read a paper on the connection between the winter temperature and the height of the barometer in North-western Europe. From an examination of the records of the barometer and temperature at several observatories, extending over many years, the author is of opinion that the winter temperature at a place in Western Europe has no connection with the height of the barometer at that place, and that in winter it is just as likely to be cold when the barometer is below the average, as when it is above the average.

Manchester.

Literary and Philosophical Society, December 13.—Mr. J. Cosmo Melvill, President, in the chair.—Dr. G. H. Broadbent described some microscopical observations he had recently made in the development of a Rotifer (*Philodina microps*) obtained from an infusion of bicycle mud. Two days after the organism was found the ovum was extruded, and was under observation for two days, when it was lost. On the following day another ovum was discovered, and the stages of development were observed day and night (with only seven hours' intermission) for four days, at the end of which period the organism emerged from the ovum fully formed.—Description of a new genus and species of Hymenoptera (*Liaba balteata*) from Chili, by Peter Cameron. The description is based on a single male specimen, which is undoubtedly closely allied to the genus *Nomadina* of the family *Trigonalidae*. This family the author proposes to divide into two tribes, *Trigonalinae* and *Nomadinae*, the former containing the genus *Trigonalis*, and the latter the genera *Nomadina* and *Liaba*.—Vestiges of primitive man found near Todmorden, by Dr. J. Lawson Russell. In July last the excavation of a curious "ring barrow" at Blackheath, near Todmorden, Yorkshire, was undertaken by Alderman Crossley and Messrs. Wilkinson and Lowe, of Todmorden, which resulted in the finding of the remains of several cinerary urns. The work of excavation was continued in November by Dr. Russell, who found a number of other urns, four of which, together with the various objects found with them—bone pins, a bronze knife, whetstones, beads of resin, lignite, pot and bone, and also several small vessels enclosed in the urns, of the kind usually known as "incense pots"—have been carefully restored by Messrs. Standen and Hardy, of the Manchester Museum. The urns, which were exhibited at the meeting, are all of different patterns and variously ornamented. The paper was illustrated by about fifty lantern slides prepared from photographs mostly taken on the spot, and showing the position of the urns *in situ* prior to removal, the disposition in the circle of the various objects found, and other features of interest.

Edinburgh.

Mathematical Society, December 9.—Dr. Morgan, President, in the chair.—The following papers were read:—Systems of circles analogous to Tucker circles, part ii., by Mr. J. A. Third; Cantor's history of Mathematics, vol. iii. part iii. (concluding): a review with special reference to the *Analyst* controversy, by Prof. G. A. Gibson.

Paris.

Academy of Sciences, December 19.—M. Wolf in the chair.—The President delivered his annual address, and gave a short account of the work of the Correspondants and Associates deceased during the past year. The prizes for the year 1898 were awarded as follows: the Grand Prize of the Mathematical Sciences to M. Émile Borel for his memoir on the part played in analysis by divergent series, M. Maurice Servant being awarded an honourable mention. The Bordin Prize was not awarded; the Francœur Prize was awarded to M. Vaschy, and the Poncelet Prize to M. Hadamard. In Mechanics, the Extraordinary Prize of 6000 francs was divided between MM. Baude, Charpy, Thiébaut, Ravier, and Moissenet; the Montyon Prize awarded to M. de Mas for his researches on the resistance of water to moving boats; a Fourneyron Prize to M. Bourlet, another being divided between MM. Carvallo and Jacob, and an honourable mention to Mr. Sharp. In Astronomy, the Lalande Prize is given to Dr. S. C. Chandler for his researches on the variation of latitude and on variable stars, M. Chofardet receiving an encouragement; the Damoiseau Prize is given to Prof. George Williams Hill for his numerous astronomical memoirs, the Valz Prize to M. P. Colin, and the Janssen Prize to M. Belopolsky. In Statistics, the Montyon Prize is awarded to M. Alfred des Cilleuls, M. Martial Hublé receiving a very honourable mention, and M. Paul Vincey an honourable mention. In Chemistry, the Jecker Prize is divided between MM. G. Bertrand, Buisine and Daniel Berthelot, Dr. C. A. Schott receiving the Wilde Prize. In Mineralogy and Geology, the Vaillant Prize is awarded to M. Cayeaux; and in Botany, the Desmazières Prize to M. G. Battista de Toni, the Montagne and La Fons-Melicocq Prizes not being awarded; but M. le general Paris and Dr. Ledoux-Lebard receive encouragements. In Anatomy and Zoology, the Thore Prize is given to M. Pantel for his contributions to the knowledge of parasitic organisms and their relations with the host, and the Savigny Prize to M. Courtière for his researches on the marine fauna of the east coast of Africa. In Medicine and Surgery, Montyon Prizes are received by MM. Widal, Sécard, Bard, Poncet and Bérard. Mentions are given to MM. Le Double, Variot, and Kirmisson, the Barbier Prize being given to Dr. J. Comby, the Bréant Prize to M. Phisalix, the Bellion Prize to M. Castaing, and the Baron Larrey Prize to MM. Regnault and de Raoult. The Godard Prize is divided between MM. Motz and Guiard, the Mège Prize between MM. Labadie-Lagrave and Félix Legueq, and the Lallemand Prize between Mr. E. P. Allis and M. Thomas. In Physiology, the Montyon Prize for experimental physiology is awarded to M. Tissot, honourable mentions being accorded to MM. Dassonville, Lesbre, Reynaud and Mlle. Pompilian, the Pourat Prize to MM. Courtade and Guyon, and the Philipeaux Prize to M. Moussu. In Physical

Geography, the Gay Prize is given to M. Sauvageau. Of the general prizes, the Leconte Prize is not awarded this year, M. Fremont receiving the Montyon Prize (unhealthy trades), Mme. Curie the Gegner Prize, M. Émilio Damour the Delalande-Guérineau Prize, M. Chaffanjon the Tchihatchef Prize, M. Édouard Branly the Houllevigue Prize, M. Félix Bernard the Saintour Prize, M. Munier-Chalmas the Estrade-Delcros Prize, and M. Merigeault the Laplace Prize. The following prizes are divided: the Jérome-Ponti Prize between MM. Guichard and Lemoult, the Cahours Prize between MM. Hébert, Metzner, and Thomas; M. Blanc receiving an encouragement, and the Kastner-Boursault Prize between MM. André Blondel and Paul Dubois and M. Paul Janet. The Rivot Prize is awarded to MM. Mérigeault, Defline, Le Troquer, and Gérin.

AMSTERDAM.

Royal Academy of Sciences, November 26.—Prof. Van de Sande Bakhuyzen in the chair.—Prof. Beyerinck, on a contagium vivum fluidum, causing the spot-disease of tobacco leaves. This disease, also known as the mosaic disease of tobacco leaves, may be inoculated into healthy plants by injecting into the stem, near a bud, sap pressed from infected plants. The active virus passes completely through the pores of very dense porcelain, and can even penetrate into agar by diffusion; therefore it cannot be a contagium fixum in the usual sense, but it must be fluid. Out of the tobacco plant it cannot be made to multiply; but in the dividing tissues of the leaf-rudiments and the meristems of the buds it multiplies freely and over a great extent. A very small drop of the porcelain filtrate can render all the leaves of the infected plant entirely covered with spots, and the sap of these leaves would be sufficient for the contagion of an unlimited number of healthy plants. The virus is destroyed by boiling at so low a degree as 90° C.—Prof. Bakhuis Roozeboom, on the phenomena to be observed on the solidification of liquids, consisting of two tautomeric forms. In the case of equilibrium being established between these forms at the temperature of solidification, these phenomena have been treated by Bancroft. A new deduction was given for those cases in which solidification takes place at temperatures at which no equilibrium can be established any more in the liquid, and specially when supposing that one passes from the region of equilibrium through two regions of one-sided equilibrium to the region of non-equilibrium. All the various consequences of slow and quick heating and cooling may be graphically represented.—Prof. Van der Waals deduced from the phase equation for a mixture, given by himself, the laws for Δ_v (the volume contraction on mixing under constant pressure) and Δ_p (the pressure contraction on mixing in given volume), and compared the results, obtained by himself, with the observations of Kuenen and others in the case of mixtures of carbonic acid and methyl chloride. According to Amagat, Δ_v would be $=0$, and according to Dalton's law, $\Delta_p=0$. The results, arrived at by the author, may briefly be summed up as follows: Δ_v is small all along the course of the isotherm, and the amount may be considered a magnitude of the same order. On the other hand, Δ_p follows a course equal to the deviation from Boyle's law, and when the volume is small it approximates infinity.—Prof. Van Bemmelen presented for publication in the *Proceedings* a communication by Mr. F. A. H. Schreinemakers, entitled, "Equilibriums in systems of three components, variation of the temperature of solution of binary mixtures by the addition of a third component."—Prof. Van der Waals, on the errors that may be committed in the determination of the molecular weight from the vapour density in consequence of the deviations from Boyle's and Gay-Lussac's laws.

DIARY OF SOCIETIES.

MONDAY, JANUARY 2.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—On Safety Explosives: Oscar Guttmann.
VICTORIA INSTITUTE, at 4.30.—The Physiography of the Thames Basin: Prof. Lobley.

WEDNESDAY, JANUARY 4.

GEOLOGICAL SOCIETY, at 8.—Geology of the Ashbourne and Buxton Branch of the London and North-Western Railway. Part I. Ashbourne to Crakelow: H. H. Arnold-Bemrose.—The Oceanic Deposits of Trinidad, W.I.: J. B. Harrison and A. J. Jukes-Browne.
SOCIETY OF ARTS, at 7.—Hands and Feet: Prof. F. Jeffrey Bell.

FRIDAY, JANUARY 6.

GEOLOGISTS' ASSOCIATION, at 8.—The Glaciers and Fjords of the Bergen District, Norway: Horace W. Monckton.
QUEKETT MICROSCOPICAL CLUB, at 8.

BOOKS RECEIVED.

BOOKS.—Das Kleinebuch von der Marine: G. Neudeck and H. Schröder (Kiel, Lipsius).—The New Gulliver: W. P. Garrison (N.Y., Marion Press).—Practical Photographer, Vol. ix. (Lund).—Die Kulturgewächse der Deutschen Kolonien und ihre Erzeugnisse: Prof. R. Sadebeck (Jena, Fischer).—Das Geotektonische Problem der Glarner Alpen: A. Rothpletz, Text and Atlas (Jena, Fischer).—Studien über Säugethiere: Dr. Max Weber, Zweiter Theil (Jena, Fischer).—Sewerage: A. P. Folwell (N.Y., Wiley).—A Text-Book of Physiological Chemistry: Prof. O. Hammersten, translated by Prof. J. A. Mandel, 2nd edition (N.Y., Wiley).—Annals of Coal Mining: R. L. Galloway (*Colliery Guardian* Office).—Fossil Medusæ: C. D. Walcott (Washington).—On the Study and Difficulties of Mathematics: A. de Morgan, new edition (Chicago, Open Court Publishing Company).—Truth and Error: J. W. Powell (Chicago, Open Court Publishing Company).—Lectures on Elementary Mathematics: J. L. Lagrange, translated by T. J. McCormack (Chicago, Open Court Publishing Company).—The Fishes of North and Middle America: Drs. Jordan and Evermann, Part 2 (Washington).

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THURSDAY, JANUARY 5, 1899.

AN EVOLUTIONAL POLEMIC.

Organic Evolution Cross-examined; or, Some Suggestions on the Great Secret of Biology. By the Duke of Argyll, K.G., &c. Pp. vi + 201. (London: John Murray, 1898.)

IT has always appeared a mystery to the writer of this notice why the phenomena of life should be dealt with by some men of science and by certain philosophical writers in a totally different spirit to that in which other groups of natural phenomena are considered and discussed. It is true that we know less about life than about other phenomena—it is true that the organic world is full of unexplained mysteries. Equally certain is it that the living organism can accomplish physical and chemical feats by processes which we are now ignorant of, and which we cannot at present imitate. But it is not obvious why because a particular department of knowledge, by virtue of its inherent difficulties and intricacies, happens to be in a different phase of development from other branches of human inquiry, that the whole domain of organic nature should be detached and delimited, and put on quite a different plane to any other department of science.

Anthropologists might offer a reasonable explanation of this difference of attitude by an appeal to the history of the development of natural knowledge. The early observers of nature and the writers of the ancient cosmogonics were not impressed by the slow and orderly course of the inorganic world in the same way that they must have been familiar with their organic environment. The facts and laws of physical science required something beyond mere casual observation for their elucidation, and the manifestations of these laws became impressive only when they reached the dignity of cataclysms. On the other hand, these writers were constantly being brought into contact with the living world in a hundred ways that had a more or less direct influence on their everyday lives. They must have noticed the plants and animals of the districts which they inhabited; the individuals of their own and other races must have been of more direct importance to them than the unobtrusive sequence of non-vital phenomena. It is not to be wondered at that in the ancient cosmogonies the living world should have been regarded in a different light to the world of "dead" matter, and a special mode of origination invoked. In brief, there has arisen a set of ideas which are even broader than "anthropocentric," and which might fairly be designated *biocentric*, and it is these ideas which, consciously or unconsciously, permeate the work now under consideration and all similar productions.

The Duke of Argyll will no doubt disclaim any such severance of vital and non-vital phenomena. In certain passages he states somewhat explicitly that he wishes it to be understood that he deals with nature as a whole in this cross-examination of evolution. But it will be evident to those who have followed the course of thought in this field, that this latest contribution from the doughty opponent of Darwin and Spencer and Huxley and Wallace is nothing but a compromise between the ancient biocentric system and the newer ideas of the order and sequence of nature. It is a kind of eviscerated Bridgwater Treatise with an aggressive binding, and with the honest and plain teleology of the writers of those famous old volumes replaced by the word Plan with a capital P. If we are not mistaken, there was a period in the author's literary career when he scouted the idea of evolution in any form. Be this as it may, he now tells us that he accepts "the leading idea of development" (p. 98), and he even goes so far as to say that he holds this idea "to be indisputably applicable to everything, and especially to organic life." The same statement is repeated in other forms elsewhere in the book (p. 189, for example). The Duke apparently prefers the word "development" to evolution. There is a subtle distinction here which the ordinary reader might overlook, and which it is therefore desirable to point out. Evolution has become associated with development through external causes controlled by, and in co-operation with, causes resident within the organism. Such, at least, is the idea which the writer has always associated with organic evolution. Development on the other hand, is associated with a process of spontaneous growth by virtue of an internal agency only. This appears to be the burden of the Duke of Argyll's tale as told in the three essays composing the present work, which essays have been reprinted, with slight alterations, from the *Nineteenth Century*.

This notion of an internal force of development implanted in the organism by an external agency is a very venerable dummy. The Duke has tried to furbish it up with a fresh coating of paint, but evolutionists will, I am afraid, not consider the new garniture sufficiently attractive to claim their attention. The old figure is still there, and the dents made by the sticks thrown at it by such skilled marksmen as Huxley and Weismann are too deep to be effaced. We find, for example, on page 155, that an essential feature of the creed of the "mechanical evolutionists" (as interpreted by the author) is "the internal directing agency or force, which always pursues a definite line of growth, so that all the demands of the completed structure must have been present from the beginning, &c." This is considered by the Duke to be a necessary consequence of the belief of the evolutionist that the development of the germ is to be explained by "processes of ordinary generation." Why, it may be fairly asked, are biologists to be so constantly reminded in wordy essays that the characters and attributes and properties of organisms must have been potentially present from the beginning of life? The whole case of the biocentric school amounts to this, and nothing more. So all the characters of a complex mineral must have been potentially present in the material atoms of which it is composed; and if there is an internal directing agency in the case of a "procreated" germ, there is just as much an internal directing agency in the mineral compelling a definite crystalline structure and chemical composition. We have never heard of any essayist taking the writer of a mineralogical treatise to task because he had failed to indicate to his readers that the structure and composition of minerals were to be explained by innate properties conferred in accordance with a prearranged plan.

We have dealt so far with these essays in their constructive aspect, but they have also a destructive side;

and here we must in fairness to the author point out that he makes some good points out of Mr. Spencer's change of view with respect to the efficiency of natural selection. The whole of the first essay is in fact a kind of merry-making over Mr. Spencer's abandonment of that excellent child of his own creation, the term "survival of the fittest." We can safely leave the Duke in the hands of the veteran author of the "Synthetic Philosophy," but in so doing it may be well to indicate that many—perhaps we may say the majority of biologists in this country—have long ago parted company from Mr. Spencer on this question of the enhanced importance of "direct equilibration," and the subordinate position assigned to "indirect equilibration" in his later writings. When, therefore, evolutionists are withered with the reproach of being "mechanical" by the noble author of these three essays, *nous autres* can take comfort from the thought that it is those who in America are called the "Neo-Lamarckians," who are expected to realise the grossness of their conceptions.

The results of attempting to recast the old idea of "creation" in the mould of the modern theory of evolution are just those results to which all attempts at reconciliation appear to lead. What these results are can only be briefly indicated here; but if, as a study of mental attitude, the philosophical student will take the trouble to compare the destructive with the constructive side of the essays, he may find much material for his instruction. For surely it is instructive to find a writer using weapons for the demolition of an antagonist without apparently being aware that these same weapons are equally destructive when applied to his own position. The Duke is acutely critical in the first essay about Mr. Spencer's phraseology. He quotes with approbation Mr. Darwin's views about explanations which are good for everything in general, being good for nothing in particular (pp. 58-60). Every man of science will join hands with the Duke on this point. But after having indulged in such exceedingly great rejoicing over the abandonment of the hateful expression, "survival of the fittest," and all that is implied thereby, the author, in a later essay, lets us into the secret of his own view of the developmental process. It is all contained in the internal directive agency; it is—

"the kind of causation which is conspicuous in the preconceived Plan, in the corresponding initial structure, and in the directed development of vital organs as apparatuses prepared beforehand for definite functions" (pp. 192-193).

Now, as far as natural and physical science has any voice in this matter, it may be equally well said that everything that happens in the universe is in accordance with a preconceived plan. But why offer this as an explanation especially to be invoked in the case of vital phenomena? It must be equally true of gravitation which causes an avalanche to overwhelm a village, or of an earthquake or volcanic eruption which destroys a city. It is precisely of that order of "explanation" which is good for everything in general, and therefore for nothing in particular. In other words, it may be the statement of a general truth or it may not—the point is one that is outside the scope of scientific inquiry—but it explains nothing, and it leaves us precisely where we were before. Curiously enough, the author tries to make Huxley responsible for this kind of explanation with respect to the vertebrate skeleton—

"a Plan, laid down from its beginning, in its originating germs, with a prevision of all its complexities of adaptability to immense varieties of use. There must have been a prevision for these uses in certain elements and rudiments of structure, and in certain inherent tendencies of growth which were to commence, from time to time, the new and specially adapted structures" (pp. 161-162; also p. 120).

This is surely doing violence to Huxley's teaching; we can call to mind no passage in his works which bears this interpretation. We ask the Duke in fairness to Huxley to reperuse the fifth chapter of the second volume of Darwin's "Life and Letters."

The importation of ultra-scientific notions into the doctrine of evolution leads the author into all those other quagmires in which others have floundered before him. The summary of the Darwinian hypothesis, on pp. 60–61, is a travesty; the conception of variability, on pp. 108–109, is a totally inadequate statement of the actual state of knowledge; the reiteration of the epithets "mindless," "fortuitous," "haphazard," &c., as applied to variation, is an impeachment of Darwin's views which has been made over and over again, and which has been met over and over again. The attempt to hurry up the course of evolution, in order to meet the limits of time imposed by certain arguments from the physical side, leads the author to accept "discontinuous variation" or development *per saltum* (pp. 122–125). It may be of comfort to the Duke to know that Mr. Francis Galton will go some way with him here. But the analogy between the rapidity of individual development in some cases, such as in metamorphosis, and the rapidity of organic evolution, which is put forward as an original idea (pp. 120–124), appears to the writer to be a false analogy. The Duke's idea of discontinuous variation is given (p. 148) in the following words:—

"It is conceivable that species might be really as constant and invariable as we actually find them to be, for some long periods of time—embracing perhaps centuries or even milleniums—and then suddenly, all at once, evolve a new form which should be equally constant, for another definite time to follow."

This may be conceivable, but we should like to have some evidence of its probability. It involves not only a sudden departure or "sport" on the part of the individual offspring, but the simultaneous and similar aberration of all the offspring of a particular generation. Even the much-abused "mechanical evolutionist" has never made such a draft as this upon the resources of the speculative faculty. The old "internal developmental force" was in the minds of its supporters a respectable kind of agency that might be expected to come into operation when the exigencies of external conditions required it. But here we have a suggested mechanism of development which makes one shudder to think what might happen if there were the very slightest hitch in the adjustment between the characters of the new form, which appeared when the proper moment had arrived, and the external conditions under which the alarum, as it were, went off.

The discussion of rudimentary organs from the author's point of view (p. 162 *et seq.*) is one of the best illustrations of the effect of introducing ultra-scientific "explanations" into the domain of natural science that will be found throughout the book. These organs are not vestigial, but prophetic. Such a rudiment

"may be where it is—simply because it indicates an original direction of growth, or of development, which was made part of the vertebrate Plan from the beginning of the series, for the very reason of its potential adaptability to an immense variety of purposes. Moreover, the arrest of such tendencies of growth, at a given point in the series, may well have been part of the same Plan from the beginning" (pp. 175–176).

The general public, who have hitherto been accustomed to consider the essence of the theory of evolution to be contained in the statement that man is descended from a tailed ancestor, will no doubt hail this statement of the Duke's with acclamation, because the rudimentary tail (which is discussed on p. 157) may after all be only "an arrested tendency of growth." The other logical alternative, that it is a preparation for a tail to be developed by generations yet unborn, is quite legitimate from this point of view, but the author will doubtless not insist upon this deduction. Similarly the rudimentary teeth and pelvic limbs of whales, which are also somewhat fully considered, are not necessarily vestigial in the sense of being the remnants of structures that were at one time functional. These rudiments are likewise to be regarded as "arrested tendencies of growth," or else as predetermined preparations for the transformation of whales into land animals. Honestly we prefer the Darwinian explanation—even though we have to face the difficulty of the electric organs of the Torpedo.

We have discussed these essays in the spirit of controversy because they are purely controversial in character. They have been considered also at greater length than their scientific importance warrants. Strictly speaking, it is difficult to see what class of readers are influenced by writings of this kind ; certainly not working biologists of any school of thought. But the unlimited hospitality extended by the editors of high-class popular magazines to essayists of the calibre of the author of the present work, shows that such writers have the public ear, and it seems desirable to let the public know that the authority which is wielded by these knights of the pen is not conferred by those whose special studies in the field of biology might be reasonably supposed to give them the right of conferring such authority. There are some minds that may be satisfied with the word "Plan" as an all-sufficient explanation of natural mysteries yet unsolved. Like "the blessed word Mesopotamia," it may convey much comfort to such minds; but the earnest seeker after scientific truth will not be deluded, and he will still go on groping his way towards a knowledge of the processes by which the universe has been evolved by the only legitimate methods of observation, experiment, induction and deduction. It may be that, as Darwin long ago suggested, a definite set of characters undergoing selection may by inheritance tend to go on varying in the same direction, and so give to the course of development an impetus as though from some internal agency. But this agency would be only apparent, and not real in the sense of being a special entity. It would be a necessary consequence of heredity combined with other properties of living organisms which are "internal" in the same sense that crystalline form is due to the play of internal forces, and in no other sense. If, as the recent investigations of Prof. Karl Pearson seem to show, there is a tendency on the part of a race to undergo change in a definite direction, this tendency is the necessary consequence of correlation between fertility and other characters of the organism. To say that the laws of inheritance are the expressions of a preconceived Plan may be a statement of pious opinion, but as a scientific explanation it is quite devoid of value.

R. MELDOLA.

THE TIDES POPULARLY AND PROPERLY TREATED.

The Tides and Kindred Phenomena in the Solar System. By Prof. G. H. Darwin, Plumian Professor of Astronomy, Cambridge. Pp. xviii + 342. (London : John Murray, 1898.)

WHEN a man of unequivocal scientific eminence lays aside the technicalities which have assisted him along the path of important investigations, and attempts to reveal as much as may be of his subject to the wide public who cannot understand mathematical processes, the result is certain to be at least interesting. And especially is this so in the case of a subject at once so fascinating and so perplexing as that of the tides. A phenomenon of such evident significance in the economy of the globe, of such important influence on the interests of maritime communities, must necessarily have been under observation from the earliest times. Naturally the conscientious pre-Newtonian philosopher could not do more than recognise a more or less indefinite connection between the periodic alternations of sea-level and the positions of the moon and sun. And if his mind happened to be of that type which trusts more readily to speculation than to accurate observation, his theories were even less enlightened in a corresponding degree. Even after the genius of Newton had laid a foundation of rational hypothesis, the theory which remained with little modification or development until a comparatively short time ago, was one which on many essential points was absolutely contradicted by facts. Now this is the theory of which a rather inadequate description is included in some popular works on astronomy, whose most conspicuous failing in general is that they attempt to cover a far wider range than is really practicable. However that may be, a short chapter in a work of this character was practically the only place where information on tidal phenomena was to be found in a popular form, with the exception, of course, of Lord Kelvin's admirable popular lectures. In consequence, the subject of the tides is perhaps the one about which, more than any other, the most widespread misapprehension exists, even among persons who are otherwise fairly well informed. The present work therefore fills a manifest need, and Prof. Darwin is certainly right in thinking "that there are many who would like to understand the tides, and will make the attempt to do so, provided the exposition be sufficiently simple and clear." His dictum, that "a

mathematical argument is, after all, only organised common sense," is indisputable, but so far from making the task undertaken in any way easier, it really emphasises the enormous difficulty. But Prof. Darwin has avowedly taken pains to render an intricate subject intelligible, and it will probably be generally agreed that he has achieved an unqualified success.

In publishing in book form the lectures which were delivered last year at the Lowell Institute, Boston, Massachusetts, the author has been distinctly well-advised to recast their form, and to eliminate all traces of the lecture-room. It is surely evident that there is one style appropriate to the platform and another to the essay, and that the two are of necessity mutually incompatible. It appears very unfortunate that the habit of publishing lectures in the form in which they have been delivered is becoming so prevalent. The result is that a little trouble is saved on the part of the author, always more or less to the detriment of his work. Is it easy, for example, to imagine a more irritating book than Tyndall's "Sound"? No doubt that is an extreme case, but the personal form of address is always objectionable to the reader, and ought to be eliminated.

As soon as one begins to examine the book in detail, one is struck by the excellence of Prof. Darwin's judgment in the choice and arrangement of his subject-matter. A liberal and comprehensive interpretation is placed upon the scope of tidal and kindred phenomena, so that a wide field of recent investigation is surveyed. But cognate branches and developments are always displayed in due order and significance of relation, and digressions, as they may appear to be at first sight, will be found in reality to be in perfect harmony with a continuous purpose.

The book begins where physical inquiry ought always to begin, in methods of observation : this course has the further advantage that the reader is not dismayed by difficulties at the outset. The construction and use of gauges for recording marine tides having been explained, the study of the changes of level in lakes is introduced in the second chapter. These Seiches, as they are called, constitute a distinct and exceedingly interesting phenomenon, which has not hitherto received the recognition it merits. Most readers, we fancy, will find much that is novel in this account. Dr. Forel's work on the subject was begun about a quarter of a century ago, but his researches, carried out on Lake Geneva with remarkable skill, have only been imitated elsewhere within the last year or two. There can be no doubt that highly important results will follow from the systematic application of Forel's methods which has been begun on Lake George, in New South Wales, and on the great lakes of North America. Not only will an appreciative description of Dr. Forel's work with those instruments of his own invention, the Plemyrameter and the Limnimeter, be found in this chapter, but also an excellent account of Mr. F. Napier Denison's application to this case of Helmholtz' theory of the waves generated at the surface of separation of two layers of fluid in relative motion. In dealing with the peculiar behaviour of the waters in tidal rivers, Captain Moore's work in observing the "bore" on the Tsieng-Tang-Kieng is described, and illustrated by reproductions from photographs.

At this point Prof. Darwin introduces an historical sketch, in composing which he has had the happy idea of levying contributions from his colleagues at Cambridge in the form of extracts from the early philosophical and mythological writers of such nationalities as Chinese and Arabic. Only after so much by way of introduction does he attack the mechanical theory. Admirably lucid chapters deal with the statics of the tide generating force and the deflection of the vertical. This provides an opportunity of describing his own researches with the bifilar pendulum on lunar gravity, of which this popular account is most welcome. This in turn leads to a short discussion of those seismological problems which are now attracting wide attention. The distortion of the earth's surface is also discussed as a disturbing factor in the problem of the direct measurement of the tidal force. The famous equilibrium theory of the tides is next examined, its value being insisted on as a statement of the statical conditions of the problem. But Prof. Darwin, unlike most of his predecessors among the popular writers on the subject, does not stop at this unsatisfactory stage, but goes on to consider the hydrodynamics of the tide-wave Prof Darwin's treatment of free and forced waves in canals in different latitudes, and of tides in lakes and land-locked seas, leaves no ground for criticism, although it is impossible but that the unmathematical reader will find great difficulty in following the reasoning which the mathematician apprehends through the medium of differential equations. Any one who has fairly well mastered the foregoing chapters should have little difficulty in understanding the one in which Prof. Darwin expounds the great modern method of harmonic analysis, though here again it is scarcely possible for any but the mathematician to realise that this powerful theory leads to a unique solution of the problem, or, in other words, that it has any sounder foundation than juggling empiricism. A clear insight ought to be gained into the method by which tidal observations are reduced and made to provide the raw material for the tide-predicting machine. The practicability of tide prediction having been realised, it only remains to discuss the degree of accuracy which has been attained. This naturally leads to a consideration of the discrepancies, and the effects of wind and barometric pressure and the variation of latitude are discussed as disturbing factors. Thus the end is reached of that section of the book which deals with the subject in its more direct aspect.

It is impossible here to give any detailed account of the remaining contents of the book, although they are of absorbing interest and eminently capable of popular treatment. In masterly chapters Prof. Darwin examines the effects of tidal friction, and discusses those particular cases in which they seem to have been most clearly manifested. The chapter on the possible equilibrium figures of a rotating mass of liquid is a good example of the author's judgment in the arrangement of his material, beginning as it does with the more easily understood experiments of Plateau, and leading up to Poincaré's remarkable work. The Nebular Hypothesis as given here in outline by Prof. Darwin does not strain the limits of conceivability as it commonly does when expounded by less able writers, but is brought well within the bounds of rational probability. An excellent summary of those

researches which have led to a definite and final conclusion as to the constitution of Saturn's rings, brings the whole work to a fitting termination.

The diagrams and illustrations, though not very numerous, are generally good and clear, with the possible exception of Fig. 23, which seems to need more explanation than is given. The bibliographical notes, which are appended to every chapter, give most valuable and copious reference to the original authorities. Prof. Darwin's book ought to be read by "all those whose minds are in any degree permeated by the scientific spirit" (preface): it is certain to excite the interest and appreciation of all such, and not least of the mathematician, in spite of the fact that there is not a mathematical symbol from one end to the other.

W. E. P.

FLORA OF ROUMANIA.

Conspectul Florei Romániei. By Dr. D. Grecescu. Pp. xvi + 835. (Bucharest: Tipografiea Dreptatea, 1898.)

THIS is a valuable addition to our knowledge of the floras of the Balkan States. Prof. Grecescu's book supersedes Branza's "Prodromul Florei Romániei," which so far has been the only comprehensive work on the flora of Roumania. Branza enumerated 2100 species, of which Grecescu admits 1875 as "good." These figures refer to Roumania, exclusive of Dobrudsha. Grecescu includes, of course, the latter, and records 2450 species besides 550 varieties. This very considerable increase is partly due to the addition of the Dobrudsha flora, partly to the admission of not a few of Schur's very questionable species and of other "species minutæ," but mainly, no doubt, to the more complete collections which were at the author's disposal. The author evidently worked under considerable difficulties. He had not only to accumulate the bulk of the material on which his work rests, but was also obliged at the same time to build up, as it seems, a general herbarium of European plants for comparison. It is only fair to mention this in order that we should not criticise too severely shortcomings which are inevitable under such conditions.

The book consists of two parts, of which the first contains the Conspectus proper, or the enumeration of the species found within the borders of the kingdom of Roumania, preceded by a synoptical table of the classes and orders; whilst the second part deals with the general physiography of the country and the principal vegetations and floras of Roumania. The author follows in the arrangement of the orders on the whole the system adopted in Nyman's "Conspectus Floræ Europeæ." Why he deviates from it in certain cases is difficult to understand, if it is not partly to suit his key of orders; but when he subdivides, for instance, the "Embriogene Dicotyledóne Apetale Unisexuate" (*i.e.* the unisexual Apetalæ) into "Angiosperme" and "Gymnosperme," including Gnetaceæ in the former, then he shows such a disregard of modern nomenclature and the results of modern taxonomy, that at least an attempt of explanation ought to have been made. In fact, it is always precarious to introduce taxonomic reforms of a higher order into local floras, and the author would have done far better if he had stuck right through to Nyman's "Conspectus."

The introductory chapters of the first part ("Clasificatiea generală" and "Dispositiea familiilor naturale") are altogether the weakest part of the work, and might have been just as well omitted as being outside the scope of the book. The same applies to the short diagnoses of the tribes, subgenera and more subordinate groups which are dispersed through the enumeration of the species. As neither the genera nor the species are diagnosed, the result is an imperfect key which is useless to the beginner who does not know the genera, whilst the more advanced student who knows them is equally puzzled, as it does not carry him far enough.

The terminology is sometimes rather loose; for instance, when the perianth of Plumbagineæ and Primulaceæ is described as "herbaceous," or the terms used are obsolete, *e.g.* when "perisperm" is applied, as it was originally by Jussieu to albumen generally. Other errors, as the description of the capsules of Primulaceæ as pyxidia generally, are evidently mere slips. On the other hand, innovations like the subdivision of Gramineæ in two tribes, Eugramineæ and Maydeæ, are quite unjustifiable.

The author distinguishes three principal zones of vegetation in Roumania, *i.e.* an Alpine zone, a forest zone and a steppe zone, and he considers Roumania as forming part of a greater and natural phytogeographical region, the region of the Flora Dacica, with the Southern Carpathians as the principal focus, and extending to the Theiss in the west, the Dniester in the east, and the Danube and the Black Sea in the south and south-east. This section of the book is of considerable interest, and it is to be regretted that the author has not accompanied it by a *résumé* in French, English or German. We are sure there are many botanists who are interested in the constitution and differentiation of the Roumanian flora, but to whom a book written in Roumanian does simply not exist. They would certainly be thankful if the author would publish a translation or a comprehensive abstract of the second part of his book in one of the languages mentioned. Either, we venture to suggest, would gain very much by a careful revision which will convince him that, for instance, the number of endemic species admitted in the Alpine zone of the Flora Dacica (fully 31 per cent.!) is far too high, or that many of the so-called Mediterranean elements can hardly claim this designation.

O. Stapf.

OUR BOOK SHELF.

De Danske Barkbiller (Scolytidae et Platypodidae Danicae). By E. A. Lövendal. Pp. xii + 212; plates 5. (Copenhagen, 1898.)

In this work Mr. Lövendal, of the Copenhagen Museum, has written a most complete account of the Danish species of bark-beetles, a subject previously dealt with by him, principally with regard to its systematic side, in Meinert's "Entomologiske Meddelelser." No European family of beetles, relatively to its size, has given rise to a more copious literature, chiefly because of its important economic relations; and in Eichhoff's "Die Europäischen Borkenkäfer," we possess already an excellent treatise on the European species known at the date of that work.

While the present monograph follows, almost inevitably, the lines of Eichhoff's work, to which it constantly refers, it is, so far as its extent goes, a great advance on that book; for the author has spared no pains in achieving an exhaustive treatment of the subject, both by his own observations and by collation of what has been written by others.

Mr. Lövendal is artist as well as author, and is already well known as the illustrator of Schiödte's "De Metamorphosi Eleutheratorum." He has executed for the present work five plates, by the now almost disused method of line-engraving, which cannot be surpassed for beauty of style or accuracy of detail. The text is furnished with some eighty woodcuts, showing the burrows of these insects in bark and wood, and the whole book is printed in the most sumptuous manner.

Such a book, written entirely in Danish and on about fifty species of a single Coleopterous family, is for the very few. But it is worthy of more general examination as a monograph which in method, fulness and finish, leaves nothing to be desired. The publication of a work of this calibre would be, we fear, at present entirely beyond the resources of British entomology. W. F. H. B.

Through Arctic Lapland. By Cutcliffe Hyne. Pp. xi + 284. (London: Adam and Charles Black, 1898.)

WE have in this volume a very interesting account of the author's journey from Vardo Island, lying in the north-east corner of Norway, to Haparanda, in Sweden, situated at the head of the Gulf of Bothnia. Mr. Cutcliffe Hyne was accompanied by his friend Mr. Cecil Hayter, to whom he is indebted for the illustrations, which form an attractive feature of the book.

On arriving at Vardo, inquiries were made as to the best means of getting across the country, and it was found that the journey was an unheard-of undertaking in the summer months, the country being chiefly swamps, lakes and rivers. In winter it would have been comparatively easy, for the ground being hard, and the water frozen, there were recognised routes, and stations where relays of deer could be obtained.

However, the travellers were not to be daunted by the apparently hopeless look-out presented to them, and they persevered, with the result that they accomplished what they set out to do.

The journey is of particular interest, for this special route had never been taken before. The incidents described are numerous and exciting, and the life and customs of the nomad Lapp are well depicted. The chief means of subsistence of this Lapp is in the possession of large herds of deer; for not only does their milk, which is thick and syrupy, form part of his daily food, but he breeds them, and rears them for selling and killing. With regard to sledge-deer, it takes three years of severe training before they can safely be driven.

All through the book we are struck with the descriptions of the beauty of the vegetation, and also with the lack of wild life. The troublesome swarms of mosquitoes and flies form a special drawback for travelling in that part. Nothing of great scientific importance is disclosed, but much which will help those who wish to visit Arctic Lapland.

The New Gulliver. By Wendell Phillips Garrison. Pp. 51. Jamaica, Queensborough, New York: The Marion Press, 1898.)

THIS is an amusing fantasy in which a shipwrecked graduate of Yale College is supposed to be cast upon an island, and to hold dialogues with a dapple-grey horse, which refused to acknowledge Prof. Marsh's *Orohippus* or *Eohippus* as its ancestors, and explained that there could be no moral sense without language; from which conclusion certain theological distinctions are drawn.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Converse of the Zeeman Effect.

I HAVE not seen it noticed that a converse action to the Zeeman effect should exist. A radiating atom in a magnetic field gives out circularly polarised light. A circularly polarised beam of light should cause a directed rotation of the electrons, so that the absorbing gas should be magnetised and exhibit magnetic force. If all the molecules in a c.c. of gas were caused to rotate their electrons in the same direction, it would possess quite a considerable magnetic moment. It is very improbable that the action of a circularly polarised beam of light would control the motions to such an extent as that: but it is quite possible that, if a circularly polarised beam of sunlight were passed through a strongly absorbing gas, it would magnetise it to an observable extent. The same effect would probably exist in any medium in which absorption was principally due to syntony and not mostly due to viscous actions. Hence I would expect some effect with absorbing substances like fuchsine. It is doubtful whether lampblack, iron, or other metals have a sufficiently syntonous absorption to exhibit the effect.

My assistant Mr. Thrift is engaged in trying the experiment, but in the meanwhile I thought it might be of general interest to point out that such an effect should exist.

GEO. FRAS. FITZGERALD.

Trinity College, Dublin, December 29, 1898.

Flow of Water.

I TOOK occasion, in the course of a paper on "The Character of Fluid Motion," read on December 14 before the Liverpool Engineering Society, to give the following reply, which I promised to Prof. Osborne Reynolds's letter, which appeared in your issue of September 15 last.

"Prof. Reynolds's comments may be placed under three headings:

"(1) An expression of disagreement with what he takes to be my views on the subject of the light border.

"(2) An explanation of the light border or bands adjacent to the solid boundary.

"(3) The expression of the belief that the water charged with air bubbles does not in any way represent the motion of the fluid itself.

"In the first place the criticism of Prof. Reynolds is based, apparently, upon a misconception of the statement in my first paper (*Trans.* Inst. Naval Architects, vol. xxxix. p. 151).

"In his letter he states as my views 'that with water in sinuous motion and air bubbles as indices of the manner of motion, the light bands adjacent to the surfaces of the solids, which show absence of bubbles adjacent to the solid, prove that the once air-charged water has not been carried by sinuous motion sufficiently near to the solid surface to displace the initially adjacent water; and hence prove that the sinuous motion does not extend up to the solid surface.' What I really wrote was, however, very different to this, viz. that the result of my observations had led me to the conclusion that the 'clear border line represents a condition of parallel flow of layers of water past the skin of the obstacle, or the sides of a pipe, in which a state of shearing exists, while outside this, in the darker portion, the water is in a state of sinuous motion, which corresponds to the state of the higher velocity of water.'

"These two statements are really very different because it was not my own belief that the once air-charged water never reached the surface, but that when it did so, the air has been removed from it for reasons which I gave (*Trans.* Inst. of Naval Architects, vol. xl. p. 45), where I stated that although I had 'purposely avoided introducing unnecessary speculations in trying to account for the observed facts, it does, however, seem that the clear film may be partly accounted for as the result of inertia, which allows the heavier water to reach the side of the submerged body, and partly from the fact that the velocity being less there, the pressure might be greater, and so the air being excluded from the portion where the water is moving with

parallel motion; whereas, it is entangled and broken up in the portion where the sinuous motion of the water occurs.'

"It will be observed that this explanation is to a certain extent the same as that subsequently given by Prof. Osborne Reynolds in the letter to NATURE, from which I have quoted, and to which I refer under heading (2).

"The experiments of Prof. Reynolds, which he cites himself, are entirely different from those of which I have given an account, and seem to me to have but very little bearing upon the behaviour of water in the conditions under which my experiments were conducted.

"With regard to the differences of state in the water in the light band, I will not trespass on your time with a repetition of the arguments which I have already published, and which have not hitherto been answered, but I would point out that the experiments you have seen to-night form a most striking method of putting the theory to the test by actually placing liquid under the condition of the thin border, and in obtaining when this is done, results which are absolutely different from those which were given by the thick film or sheet of water. This is one of the strongest possible arguments in favour of the views which I have advanced, inasmuch as the results of the experiment seem to have surprised some of the greatest authorities on the subject.

"Coming to (3), I would first remark, though it has never been distinctly claimed, that the water charged with air actually represented real stream-line motion, in my first paper it was stated that 'there was no difference whether the smallest quantity of air was present, or so large a quantity as to render the slide opaque, as the general behaviour of the flow of water was practically unaffected by the presence of the air.'

"Though this remark only applied to the general nature of the results obtained, the experiments brought out very strongly, I believe for the first time, various points which had long been known to the naval architect, but which had not been actually made visible to the eye. Prof. Osborne Reynolds, however, states that 'air bubbles are the most misleading bodies that can possibly be chosen to indicate the lines of motion in a fluid in sinuous motion.' This remark led me to consider the very appropriate experiment of trying the effect of first taking the air-charged water upwards and then taking it downwards under the same conditions. Inasmuch as the air in one case was trying to rise upwards through the water, which is moving in the same direction, whereas in the other case it is trying to move in the opposite direction, it is perfectly certain that if there was much difference in the flow owing to the presence of air, it would become marked under those circumstances.

FIG. 1.

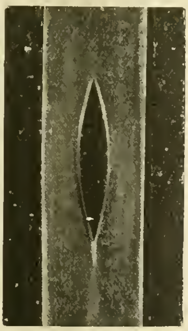


FIG. 2.

"The two photographs, Figs. 1 and 2, represent the results of this experiment, and I venture to think that no one would be able to tell from the photographs themselves where the air-charged water was flowing upwards or where it was flowing downwards. This, I think, shows in a very striking way the comparatively small effect which the presence of air under *suitable* conditions, has upon the flow of the water, and it is quite contrary to that which Prof. Osborne Reynolds seems to anticipate."

The truth of the whole matter appears to be this, that as far as Prof. Osborne Reynolds has dealt with the behaviour of air in water, it has been under conditions represented by plates suddenly immersed or moving through still water, in which case air has been in a state of bubbles of large size, whereas in my own experiments, the air has been broken up into very minute bubbles. The behaviour in the two cases has been as different as that of a mass of water, say from a bucket, thrown through the air, and the finely-divided particles of moisture in a fog or mist. The effect of viscosity makes all the difference in the two cases. As, however, I have never had an opportunity of seeing Prof Osborne Reynolds's experiments, and as he has never witnessed mine, perhaps his disagreement with me is, after all, only another illustration of the old fable of the chameleon.

H. S. HELE-SHAW.

University College, Liverpool, December 21, 1898.

Etherion, a New Gas?

SOME months ago the discovery of a new gas, by Mr. C. Brush, was announced by nearly all the scientific periodicals of the world, which was said to be endowed with quite extraordinary properties; as, for instance, density one ten-thousandth of hydrogen, molecular velocity and heat conductivity hundred times that of hydrogen!

It seemed strange to me that such tremendous assumptions should be based on no more convincing arguments than the experiments (Mr. Brush's) reported therein, on the relative increase of condition of heat in rarefied air, when glass powder, contained in the same vessel, was being heated, and I was waiting eagerly for the publication of the original account (Mr. Brush's), since it struck me that all observed phenomena could be explained by the well-known properties of water vapour.

I was glad to learn afterwards, from a paper in the *Chemical News* (November 4, p. 221), that this is also the opinion of Sir William Crookes, undoubtedly the greatest authority in this kind of research.

Now the original paper (Mr. Brush's) appeared in *Science* for October 14. It has been already the subject of a severe criticism by "A Physicist" in the *Chemical News* (December 2, p. 277), as it does not contain indeed any further argument for Mr. Brush's hypothesis. I do not think it superfluous, however, to warn in NATURE, too, against an excessive credulity in this matter, and to point at some facts not yet emphasised sufficiently by other sceptics.

First I must mention, for the sake of those readers who are not sufficiently acquainted with these things, that the conduction of heat by gases, when not disturbed by convection currents, is independent of the pressure, until this comes down to several millimetres of mercury; then it begins to decrease, at first very slowly, then faster, until it becomes nearly proportional to the pressure, at the highest rarefactions; and the differences of conduction in various gases, very marked at higher pressures, are much less at pressures of several millionths of an atmosphere.

These facts, which are in strictest accordance with the kinetic theory of gases, as I have shown in the *Phil. Mag.* (August 1898), have been investigated besides by other observers very carefully, also by Mr. Brush himself, and form the object of a very interesting paper of his in the *Phil. Mag.* (January).

Mr. Brush found that the conduction of heat is increased very much at high exhaustions in respect to other gases at corresponding pressures, when glass powder is heated (but remaining always much smaller than at normal pressures), and he infers from this that a gas of enormous conductivity is given off by heated glass powder.

Now to me the main point seems to be—how did Mr. Brush measure these low pressures? By an improved form of the Macleod gauge, which seems to be very suitable for dry gas, but of course, like every Macleod gauge, is quite unfit for gases where moisture or other condensable vapours are present, since then it indicates only the partial pressure of the not condensable gas. He did not use any drying agents, since they absorbed the gas in question, therefore the indications of the gauge are of no value whatever as to the total gas pressure.

When Mr. Brush measured a gas pressure of 0·38 millionth, and found the conduction to be about forty times that of dry air at this pressure, he may have had in reality a pressure of 0·38 millionth of air, and besides a pressure of 20 millionth of

water vapour, which of course would be sufficient to account for that large effect.

Sir William Crookes mentions that, according to his experiments, water vapour produces a greater conduction at very low pressures than air; but I decidedly disbelieve the difference to be in any way similar to the numbers given by Mr. Brush, in consequence of a reasoning mentioned at the end of my *Phil. Mag.* paper, and I think the simplest explanation to be afforded by this source of errors vitiating the pressure indications.

It is no mere hypothesis but a certain fact that water vapour is being evolved by heated glass, and probably many other substances. Sir William Crookes gathers quite a number of arguments for it from his own researches, amongst others spectroscopical proofs. The same opinion was put forward by Kundt and Warburg, who were led to it by the very same sort of experiments on conduction of heat as Mr. Brush's, which they made as early as 1875 (*Poggendorff's Annalen*, 156, p. 177). Further investigations on the hygroscopical properties of glass, and on means for partially removing them, were published by Warburg and Ihmori (*Wiedemann's Annalen*, 27, p. 481).

I cannot prove, of course, that there is no new gas evolved, but I maintain that whatever facts Mr. Brush has put forward as an evidence for its existence, can be explained quite simply by the presence of water vapour (perhaps also other condensable vapours), which he seems to have overlooked. I do not think it necessary to go into details, and to analyse more thoroughly the—rather fantastic—speculative part of the paper, where scarcely any statement is not open to serious objections.

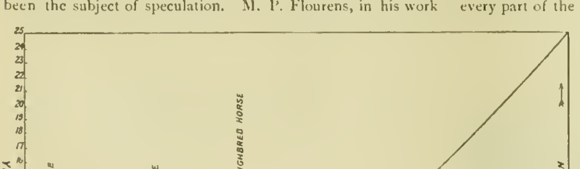
Although thus I differ from Mr. Brush very much in respect to the interpretation of his recent results, I think his elaborate experimental investigations, as reported in his *Phil. Mag.* paper, to be of great value for the theory of these phenomena; certainly it would be very desirable that he might carry on those researches, as he promised there to do.

M. SMOLUCHOWSKI DE SMOLAN.

Vienna, University.

The Curve of Life.

THE relationship between the duration of adolescence and potential longevity in different species of mammals has repeatedly been the subject of speculation. M. P. Flourens, in his work



on "Human Longevity," made the ratio between the two periods as 1 to 5; Buffon had previously concluded that it was as 1 to 7. In neither case were the data sufficiently numerous and trustworthy to make these figures generally accepted. In the course of some investigations on the variability of the adolescent period in different breeds of the same species among certain well-known mammals, I have satisfied myself that a relationship exists between the duration of growth and the length of an animal's natural life; although it is evidently not of the kind suspected by the older writers. It may be stated as follows:—The ratio of length of adolescence to length of life in the shortest lived mammals is proportionally less than it is in longer lived mammals. For example, the period of growth and development of the domestic mouse is, according to my informant, a breeder of these small rodents, about three months. Its natural lifetime is four years. In other words, the mouse may be expected to live about fifteen times its adolescent period as a mature animal. The Arab horse, according to a well-known authority, arrives at maturity in about eight years, its lifetime is about forty years; that is to say, the animal lives four times the length of its adolescence as an adult. Man, on the other hand, who only completes his growth by the union of the sternal epiphysis of the clavicle to its shaft at the age of twenty-five, has, after passing his fiftieth year, or "the middle arch of life," to use Dr. Farr's phrase, only another twenty-five years' expectation of life. His potential longevity accordingly foreshadows a period of maturity not greater than twice the length of his youth.

I have obtained, through the kindness of numerous correspondents interested in breeding and rearing of farm and other domestic animals, the approximate lengths of these two periods in a few well-known mammals; and the accompanying diagram shows the relations between growth and longevity among the same animals plotted as a definite curve. This result was entirely unexpected by me, and it may be interesting to some of your readers.

W. AINSLIE HOLLIS.

Hove.

The Alleged Destruction of Swallows and Martins in Italy.

IN your issue of December 22, 1898, I read the report of a conference held by the Society for the Protection of Birds, at which a paper was read on the decrease of swallows and martins coming to England, giving, as a reason for this decrease, the netting of thousands of these birds on their arrival at the Italian shores, and their subsequent consumption as food.

May I venture to remark that, during a residence of some years in Italy, I have never once seen a swallow, or any member of its family, exposed for sale, and that I have never known, or heard of, an instance of their being netted in the manner described, though I am well acquainted with nearly every part of the Peninsula.

Since reading the above mentioned accusation against Italy, I have asked several Italians whether they knew of such a practice, and am informed that it is simply non-existent, the swallow being, perhaps, the one bird in this country which is regarded with a kind of sentiment by all classes, as the harbinger of spring.

Swallows, moreover, do not arrive on these coasts in a state of exhaustion, and to net them would be no easy feat.

A few isolated cases of the cruel method of capturing them with artificial flies may occur, but not more so than in England.

The Italian may be ruthless in his destruction of other birds, but is certainly not a destroyer of the *Hirundinidae*.

Of the similar charge made against the French, I am not in a position to judge, but I imagine that the cause for the decrease of the *Hirundinidae* in England may lie in quite another direction, and may be attributable to some equivalent decrease of their favourite insects in our islands, or in some atmospheric and climatic change. Italy, I am convinced, is not responsible in any way for it.

RICHARD BAGOT.

Roma, December 27, 1898.

RADIATION PHENOMENA IN THE MAGNETIC FIELD.

IN the spring of 1897 the scientific world became indebted to Dr. Zeeman for the observation that when a source of light is placed in a strong magnetic field the spectral lines of the light emitted by that source suffer

marked modification. The general type, or characteristic type, of this modification is that when the slit of the spectroscope views the sources of light across the lines of magnetic force, each spectral line becomes a triplet, of which the middle line has the same wave-length as the original line; whereas the side lines of the triplet have wave-lengths, respectively, a little longer and a little shorter than that of the unmodified line, the difference of wave-length being proportional to the strength of the magnetic field. Further, the central line has its vibrations parallel to the lines of force, whereas the side lines of the triplet have their vibrations perpendicular to the lines of force. Thus, if the axis of the magnetic field is horizontal, so that the lines of force are horizontal, and if the slit of the spectroscope looks horizontally across the lines of force, then in the central constituent of the triplet the vibrations are horizontal, while in the side lines the vibrations are vertical. Thus the central line is plane polarised, and the side lines are also plane-polarised, but in a perpendicular plane. This is the typical phenomenon when the light is viewed across the lines of force. When the light is viewed along the lines of force—that is, through axial holes pierced in the pole-pieces of the electromagnet, the modification is different. In this case, instead of a triplet with plane polarised constituents, we are presented with a doublet, having circularly polarised constituents. That is, each spectral line is broken up into two lines of slightly different wave-length; one constituent being circularly polarised in one sense, and the other in the opposite sense. As before, the difference of wave-length, and therefore the separation of the constituents of these doublets in the spectroscope, is proportional to the strength of the magnetic field for each line, but differs in amount for the different spectral lines.

In order to fix the ideas of those who are not familiar with this department of physics, the phenomena described above are represented diagrammatically in Fig. 1. Thus at A the upper single line is supposed to represent a bright spectral line of some substance when the radiating source is not influenced by the magnetic field. This line becomes converted into three distinct lines, that is a triplet, as shown underneath at A′, when the source of light is subject to a strong magnetic field, and the radiation takes place across the lines of force. If N be the vibration frequency of A, then the vibration frequencies of the members of the triplet A′, into which A is converted, are N − n, N, N + n, where N is a small quantity depending on the strength of the magnetic field. On the other hand, when the source of light is viewed along the lines of force a bright spectral line, B, becomes converted into a doublet, B′, consisting of two distinct lines which are circularly polarised in opposite senses. The constituents of the triplet A′ are, on the contrary, plane polarised, the direction of vibration in the middle line being horizontal, while that in the side lines is vertical.

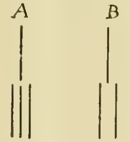


Fig. 1.

The foregoing are the phenomena demanded by the simplest form of theory, and they are the phenomena actually yielded by experiment in the case of the vast majority of spectral lines. Many lines, however, when carefully examined in a sufficiently strong magnetic field, yield phenomena which differ in a remarkable manner from the simple theoretical expectation described above. In some cases the middle line of the triplet becomes resolved into a pair of lines so that the triplet becomes a quartet, while in other cases each line of the triplet becomes a pair, and thus a sextet is produced; and in some cases the side lines of the triplet become resolved into triplets, while the middle line becomes a doublet, and then an octet is produced, and so on. Thus generally, when the light is viewed across the lines of force, we may say a single spectral line becomes resolved by the magnetic field into a system of lines consisting of a central part bordered by two side parts. The central part may consist of one or more lines, and is plane polarised, while the side parts may each consist of one or more lines, and are also plane polarised in a plane at right angles to the plane of polarisation of the central part.

On account of this opposite polarisation the central part may be quenched and the sides examined separately, or *vice versa*, by means of a nicol's prism, and consequently the existence of this plane polarisation enables us to scrutinise the phenomena much more closely and effectively than would be otherwise possible unless, indeed, a magnetic field of any desired strength could be produced so as to obtain complete and wide separation of the various constituents of the modified line. But it is not possible at present to produce a magnetic field for working purposes of a strength exceeding 30,000 to 40,000 C.G.S. units. Hence the polarisation is of importance for purposes of observation. The best way to take advantage of it is not to use a nicol's prism (which lets through only one of the two plane polarised beams), but to use instead a double image prism, or a rhomb of doubly refracting crystal, placed before the slit of the spectroscrope, so that two images of the source are produced on the slit, one above the other (the slit being supposed vertical). Of these images one consists of light vibrating horizontally—that is, it consists of the light which forms the central part of the triplet A′ (Fig. 1), while the other image consists of light vibrating vertically—that is, the light which forms the sides of the triplet A′ when the magnetic field is excited. These two images on the slit give rise to two spectra in the field of view of the spectroscope, one above the other: one consisting of the lines which form the centres of the triplets, and the other of the lines which form the sides. This is shown in Fig. 2, where A represents a triplet as seen in the field of view, without the use of any nicol or double image prism, and A′ represents what is seen when a double image prism is used. The upper line in A′ represents the light vibrating horizontally, and is what would be seen if a nicol's prism were placed before the slit with its principal plane vertical; whereas the two lines below in A′ are formed by the light vibrating vertically, and constitute what would be seen were the nicol turned through a right angle. With the double image prism, however, the upper and the lower lines in A′ are seen simultaneously, and so a great deal of trouble is avoided, and much time is saved when the phenomena are being photographed. But the chief advantage of separating the middle from the side lines, as at A′ (Fig. 2), lies in the fact that in many cases the difference of wave-length of the middle and the side lines is so small, even in a very strong magnetic field, that the width of the lines causes them to overlap, and so obliterate the phenomena. It was for this reason that in the earlier experiments made by Dr. Zeeman, merely a broadening of the spectral lines was observed, and not a tripling. In fact, it was not until theory pointed out that tripling and plane polarisation should exist across the lines of force, that Zeeman interposed a nicol's prism, and found that the broadened line exhibited the polarisation required, and that the facts were not discordant with the theory. It is to be observed, however, as I have pointed out elsewhere, that the removal of the central part from the broadened line by a nicol properly interposed (so that

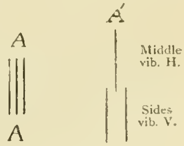


Fig. 2.

the broadened line now appears as a doublet), does not absolutely prove that the broadened line is a triplet with its components overlapped. It merely determines that the broadened line may be a triplet, and that the theory which anticipates the tripling may be correct. In order to place this matter beyond all doubt, it is necessary to so increase the strength of the magnetic field that the components of the triplet (if they exist) shall be completely separated from one another; and when this[1] is done, it is found that the tripling exists, but it is also found that many divergencies from the uniform expectation of theory (pure tripling) exist. Thus, as pointed out above, many lines under the influence of the magnetic field show as quartets, or sextets, or octets, or other modified form of the normal triplets. In the examination of these cases the double image prism forms a very valuable adjunct, as all the light polarised in one plane goes to form one image, while all the light polarised in the perpendicular plane forms the other image. The appearance presented in the field of view of the spectroscope by different types of lines, under these circumstances, is shown in Fig. 3. In this figure the lines of the upper row are formed by one image from the double image prism—that is to say, by the light vibrating horizontally, and correspond to the central members of the normal triplets; while the bottom row consists of light vibrating vertically, and represents the side lines of the normal triplets. Thus at A A′ we have the normal triplet, as expected by theory, with the central line, A, polarised in one plane, while the two side lines, A′, are polarised in the perpendicular plane. This type exists in the case of by far the greater number of spectral lines, and may be regarded as the general or normal type, if for no other reason than the frequency with which it occurs. The second type, shown at B B′, is a quartet in which, instead of a single middle line, we have two middle lines close together at B, with the two side lines at B′ as before. This type of quartet occurs in the blue cadmium line 4800, and in the blue zinc line 4722. At C C′ another species of quartet is shown; in this there are two middle lines also, but the separation of these is almost as wide as that of the side lines, so that the appearance presented to the eye when the double image prism is not used is that of two fine doublets, rather than the quartet appearance of the type B B′. This third type, C C′, occurs in the case of the sodium line D_1, the greenish-blue line of barium 4934, and many others. The fourth type, D D′, is a sextet of fine uniformly spaced lines, two of which correspond to each component of the normal triplet. That is, the central component is a doublet, and each of the side components is also a doublet. This type is represented by the line D_2 of sodium. The fifth type is shown at E E′, where the central constituent is a doublet, and each of the side components is a triplet. The distance between the components of the central doublet in this case is about the same as that between the central members of the side triplets. This type is represented in the yellow line of barium 5850. All the variations so far noted may be embraced in the general statement that each line of the normal triplet A A′ may itself become a doublet or a triplet.

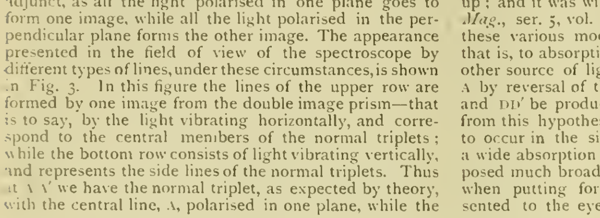


FIG. 3.

The question now of greatest importance is whether these various types of modification by the magnetic field are consistent with the theoretical explanations of the phenomena put forward by Larmor, Lorentz, and others? Naturally one must endeavour to reconcile facts and theory. If this reconciliation has not yet been effected, we must not hastily conclude that the theory is wrong, or even that it requires to be modified or patched up; and it was with this feeling that I put forward (*Phil. Mag.*, ser. 5, vol. xlv. p. 325, April 1898) the idea that these various modifications might be due to reversal—that is, to absorption in the outer parts of the spark or other source of light. Thus B (Fig. 3) might arise from A by reversal of the middle line, and so also might C C′ and D D′ be produced, and even E E′ might be intelligible from this hypothesis if we supposed double reversal to occur in the side components of the triplet A A′, and a wide absorption band to occur in the middle line (supposed much broader than the others). But (as I stated when putting forward this view) the appearance presented to the eye is not that of ordinary reversal, so that appearances are against the supposition that the modifications are due to absorption in the vapour surrounding the source of light. But still it is to be remembered that the magnetic field exerts a considerable influence on the source of light, and might alter considerably the appearance of an ordinary reversal. However, in order to test this matter, I observed many lines, which deviate from the normal triplet type, in a magnetic field of gradually increasing strength. The object of this was to determine if the separation of the lines forming the upper row in Fig. 3 (say, the doublet B or C) depended on the strength of the magnetic field. Thus, if the components of the doublet B remain fixed while the distance between the side lines B′ continues to increase as the magnetic field increases in strength, then we might conclude that reversal is not only a possible explanation by very probably the true explanation. But the components of the central parts B, C, D, do not remain fixed as the magnetic field increases in strength. On the contrary, the distance between the two lines B increases as the strength of the field increases; indeed, as far as rough observations go, the distance between the components of B or C, like the distance between the side lines B′ or C′, is proportional to the strength of the magnetic field. Similar remarks apply to the types D D′, E E′, &c. When the field increases in strength, the lines forming D separate from each other, and so also do the doublets D′, and the lines forming each component of the latter also separate, so that the sextet remains a system of equally spaced lines. On the other hand, when the field is reduced in strength the various lines close up till B, C, D, E each appears as a single line with B′, C′, D′ as narrow doublets—in fact, the normal triplet type is approached in appearance as the field is reduced.

It appears, therefore, that the explanation of the various modifications of the normal triplet type cannot be satisfactorily explained by reversal, and consequently these divergencies must be referred to the action of the magnetic field on the vibrating structure which emits the

[1] This was effected by the writer in October 1897, and triplets and quartets were then photographed directly without the aid of a nicol or any polarising apparatus whatever. (See letter to NATURE, dated November [illegible], 1897, vol. lvii. p. 173.) These photographs were shown at the November meeting of the Dublin University Experimental Science Association, at the December 1897 meeting of the Royal Dublin Society, and at the January 1898 meeting of the Royal Society of London; but it was not till April 1898 that they were reproduced in the *Philosophical Magazine* (5th series, vol. xlv. p. 325, plate xviii.).

radiation. Now the theory which indicates that a spectral line should be slit up into a pure triplet by the action of the magnetic field, assumes that the freedom of vibration is the same in all directions, and it is from this that the resolution into triplets occurs. This assumption is that which one most naturally makes in a first attack on a problem of this nature, but no one making it would be surprised if the facts did not turn out more complicated than the prediction of such a solution. For example, it is quite possible to conceive a state of affairs in which the magnetic field may constrain all vibrations to take place along the lines of force, in which case the side lines of the triplet would vanish; or, on the other hand, vibration in the direction of the lines of force might be impossible, in which case the central line of the triplet would vanish. Indeed, one is somewhat surprised that deviations of this kind from the normal triplet type do not more frequently occur. In fact, when I first examined the spectrum of iron, I hoped to find many deviations of this kind, but failed to detect any very marked difference between the behaviour of iron and other substances. This is not much to be wondered at when it is remembered that iron ceases to be magnetic at a comparatively low temperature, and, therefore, at the temperature of the spark of an induction coil, one should not expect its vapour to behave much differently from that of any other substance.

However, as already stated, the normal triplet type arises in theory because the orbit of the vibrating electron is supposed free from constraints and perturbations—that is, that movement is equally free in all directions. When constraints are imposed, or new forces arise which cause perturbations in the orbit, new frequencies will be introduced into the vibrating system. Thus if an electron, or an atom, or a particle describes an ellipse under a central force with frequency N, and if disturbing forces came into play which cause the apse line to rotate with frequency n, then, as Dr. Stoney[1] has shown, a spectral line arising from the original vibration of frequency N will become replaced by two others of frequencies $N + n$ and $N - n$ respectively. Again, if the disturbing forces cause a precessional motion of the plane of the orbit round a fixed line with frequency n, the original vibration of frequency N becomes replaced by three others of frequencies $N + n$, N, and $N - n$ respectively, and similar phenomena arise when other periodic disturbances occur in the orbital motion. We are prepared, therefore, to find that each line of the normal triplet may become itself a doublet or a triplet.[2]

The disturbing forces arising from the action of the magnetic field should increase with the strength of the field, so that if the distance between components of the doublet B or C or D or E (Fig. 3), which takes the place of the central line of the normal triplet, should increase with the magnetic field, as it is found to do by experiment. In fact, if the distance between the side lines of the normal triplet AA′ be written in the form $d_1 = k_1H$, where H is the strength of the field, and k_1 a quantity depending on the wave-length and other constants involved in the production of the particular line in question, then the distance between the components of the modified central component B, C, &c., may be written in the form $d_2 = k_2H$. Thus as the field increases in strength the whole system of lines into which any given spectral line becomes resolved, separate laterally from each other proportionately, as it were, according to a given scale Similar remarks, of course, apply to systems like DD′ and EE′.

Now in any particular case, such as BB′ for example, if the distance between the pair of lines B′ is

$$d_1 = k_1H$$

while the distance between the pair B is

$$d_2 = k_2H$$

there is apparently no reason why k_1 should be greater than, or less than k_2. Whether k_1 is greater than or less than k_2, must be determined by the action of the magnetic field on the system which produces the particular spectral line in question. Accordingly we are prepared to find that in some lines the components of the central line, as at B, shall be much closer together than the side components at B′, while in others, as at C, E and F, the distance d_2 is nearly equal to, or may be even greater than the distance d_1 between the side lines. Thus, once the production of a quartet of the type BB′ is explained, all the other modifications become intelligible. The case in which the components F are wider apart than the side lines F′ (so that the centre, as it were, encloses the sides) is merely the same phenomenon (only more accentuated) as that shown at BB′ where the separation d_2 is less than d_1. This point is mentioned here specially because in some cases the separation d_2 is actually greater than d_1, and it seems to be regarded as a difficulty of a much higher order than that in which occurs in the ordinary quartet, where d_2 is less than d_1.

Lines of the former type FF′, viz. that in which d_2 is greater than d_1, seem to have been first observed by MM. Henri Becquerel and H. Deslandres (see *Comptes rendus*, t. 126, p. 997, April 4, 1898) in the spectrum of iron, and subsequently Messrs. J. S. Ames, R. F. Earhart and H. M. Reese announced that they had observed the form GG′ (Fig. 3) in the spectrum of iron. In this type the side lines G′ coincide, or are not sensibly separated, while the components of the central part G are well separated.[1] (see *Astro. Phys. Journal*, vol. viii. p. 48, June 1898). The form in which this observation was described was calculated to startle, if not confound, the most firm believer in theory. It was said that these lines exhibited *reversed polarisation*—that is, that the polarisation of the centre is that which should occur in the sides, and *vice versa*. Stated in this way it is rather calculated to take one's breath away, but when stated as in the foregoing, it loses all special significance, viz. that it is merely a case of d_2 being greater than d_1, that is $k_2 > k_1$, or a quartet in which the distance between the horizontally vibrating constituents is greater than the distance between the vertically vibrating constituents. Stated in this way it falls into line with the other phenomena, and is reduced to the explanation of the doubling of any one individual member of the normal triplet.

Other similar modifications have been observed by MM. Becquerel and Deslandres, who appear to have examined the spectrum of iron very thoroughly as well as the bands of carbon and cyanogen. These bands they found to be unaffected by a magnetic field strong enough to sensibly split up the air lines.

Investigations demanding special attention are those of Prof. A. A. Michelson, both on account of his reputation as an original investigator and by reason of the nature of the apparatus which he employed. Working with his interferometer, Prof. Michelson concluded some years ago (*Phil. Mag.*, vol. xxxiv. p. 280, 1892) that the spectral lines themselves instead of being, as ordinarily supposed, narrow bands of approximately uniform illumination from edge to edge, are on the contrary in most cases really complexes, some of them being close triplets, and so on. This structure has never yet been observed by means of any ordinary form of spectroscope, and accordingly it has been suggested that it does not

[1] Dr. G. J. Stoney, *Trans. Roy. Dub. Soc.*, Vol. iv Series 2, p. 563, 1891. This is a very important paper when considered in connection with the above-mentioned magnetic perturbations of the spectral lines.

[2] These matters are treated in further detail in a paper by the present writer to appear in the forthcoming number of the *Philosophical Magazine*.

[1] I have not yet observed this type, nor do my photographs verify the conclusion of Messrs. Ames, Earhart and Reese, regarding the lines mentioned by them as belonging to this type. (This is further referred to in the forthcoming number of the *Phil. Mag.*)

exist in the light radiated from the source, but is imposed on the spectral lines by the apparatus used, namely, the interferometer. Be this as it may, the application of this instrument to the study of radiation phenomena in the magnetic field is highly interesting. In his first experiments Michelson merely observed a *doubling* of the spectral lines both along and at right angles to the lines of force (!), but subsequent observations proved that tripling occurred across the field of force, and that the constituents of the triplets were themselves multiple lines (see *Astro. Phys. Journal*, vol. vi. p. 48, 1897; vol. vii. p. 131, 1898; vol. viii. p. 43, 1898). But this is accompanied by the most surprising statement that the separation of the lines in the triplets produced by the magnetic field is independent of both the spectral line and the substance. In other words, that the separation is the same for all lines and all substances! Now, in all observations with ordinary grating or prism spectroscopes the separation of the components produced by the magnetic field varies very considerably for the different spectral lines of the same or of different substances. Even in the case of lines of nearly the same wave-length the difference is often very marked. The separation not only differs for different substances, but it is some complex function of the wave-length for any one substance. That the interferometer has led to such a law as that announced by Prof. Michelson, shows that there is some peculiarity of the instrument not yet taken into account—or else that by chance Prof. Michelson has happened to confine his observations to lines which give approximately the same separation; yet this latter could not be easily done. Be this as it may, Michelson has examined these phenomena by aid of another new instrument of his own design—the Echelon spectroscope (*Astro. Phys. Journal*, vol. viii. p. 43, 1898). With this instrument he states that the results previously obtained by aid of the interferometer, and the visibility curve, were confirmed. And this is striking, for if it confirms the general law stated by him in regard to the separation of the components, then the interferometer and the Echelon spectroscope are at variance with all other forms of spectroscope.

With apparatus which reveals structure or multiplicity in the ordinary spectral lines, it is to be expected that multiplicity would be readily revealed in the constituents produced by the magnetic field; yet in the case of some lines, the amount of finer structure revealed does not appear to be as great as that observed with a good grating, and this with other discrepancies require clearing up. If we suppose that an ordinary spectral line really consists of two or more very close lines, not separated in ordinary spectroscopes, and if we suppose that this multiplicity is produced by small perturbations caused by events inside the molecule, then it is clear that the further perturbations (if any) brought about by the magnetic field, may either increase, or diminish, or possibly reverse, those previously existing in the free field. And from this point of view the following most interesting observations made by Michelson (*loc. cit.*) become intelligible. "A very remarkable effect is observed in the case of the yellow copper line. This line without the field is a close double, the distance being 1/150th of the distance between the D lines, or 0·04 A.V. As the field increases the lines merge together without broadening, and with a strong field there is but a single narrow line."

"The behaviour of the yellow-green line of manganese is even more striking. The line is a quadruple line, just resolvable. In a weak magnetic field the light accumulates in the centre of the group, the lines becoming indistinct and merging together. In a strong field the quadruple band is reduced to a single fine line at the centre of the group."

In conclusion, it is necessary to mention briefly some ingenious methods which have been devised to exhibit the existence of the Zeeman phenomena in comparatively weak magnetic fields. The first of these chronologically was devised by M. Cotton (*Comptes rendus*, t. 125, p. 865) in 1897, and depends upon the fact that if a small sodium flame, A, be placed in front of a larger one, B, and viewed against it, the outer edges of the small flame appear dark. This arises, as is well known, from the absorption which takes place in the outer sheath of the smaller flame. If, however, the flame B be placed in the magnetic field, the dark border around A disappears. This arises from the fact that the magnetic field induces new periods of vibration in B (the side lines) which are not possessed by A, and therefore not absorbed.

The next experiment to be mentioned is one of special elegance, devised by Prof. Auguste Righi (*Comptes rendus*, t. 127, p. 216, 1898, and *Rend. della R. Accad. dei Lincei*, July 1898). If a plane polarised beam of light from a powerful source, such as an arc lamp, be transmitted through an absorbing vapour, such as a sodium flame, or sodium vapour in a tube, and if the light, after passing through the vapour, be transmitted through a nicol's prism, and then received on the slit of a spectroscope, a continuous spectrum will be observed in which dark lines occur corresponding to the absorption lines or bands of the vapour. If the analysing nicol be rotated till its principal plane is perpendicular to that of the polariser, then all light in the spectroscope will be extinguished.[1] Now suppose this to be so arranged, and suppose, further, that the absorbing vapour is between the pole-pieces of a magnet so as to be subject to the action of the magnetic field, and suppose that the light passes through this vapour along the lines of magnetic force by passing through axial holes pierced in the pole-pieces, then under these circumstances, if the magnet be excited, bright lines appear in the spectroscope corresponding to the absorption lines of the vapour. At first sight it appears as if the magnetic field caused the vapour to emit its own vibrations as if it were highly luminous. It is not so, however. The explanation is that the magnetic field so affects the vapour, that if it were self-luminous any spectral line appertaining to it of frequency N is converted into two other vibrations of frequency $N + n$ and $N - n$ respectively; and these two, along the lines of force, are circularly polarised in opposite senses, and consequently the vapour when cold possesses the power of absorbing vibration of frequencies $N + n$ and $N - n$. Now the beam from the electric arc passing through the vapour being continuous, possesses vibrations of frequency $N + n$ and also of frequency $N - n$. These vibrations in the arrangement, described above, are plane polarised, and any plane polarised vibration is equivalent to two opposite circular vibrations. The result is that the vapour absorbs one of the circular components from the rectilinear vibration $N + n$, and transmits the other. In the same way it also absorbs one of the circular component vibrations from the vibration $N - n$, and transmits the other. These transmitted circular components are very intense (having evidently half the intensity possessed by the arc light), and they cannot be extinguished by the analysing nicol, so they consequently appear in the spectroscope. If the magnetic field is not very strong, the vibrations $N + n$ and $N - n$ practically coincide with N, and what is presented to the eye is that the absorption lines of the vapour become bright when the magnetic field is excited. This can be observed in fields of very small intensity.

Prof. Righi mentions that the phenomenon observed in the foregoing experiment does not occur when the light traverses the vapour in a direction perpendicular to the lines of force. This is a result which differs from

[1] If a sodium flame be used as the absorber, then of course faint sodium lines will still remain. For this reason the sodium flame used should not be bright.

the theoretical expectation. For an emission frequency N of the vapour will now be converted, across the lines of force, into absorption frequencies $N+n$, N, and $N-n$. The first and last being for vertical vibrations, and the central one for horizontal vibrations. If, therefore, the plane of polarisation of the incident light (arc lamp) be inclined at any angle a to the vertical, its horizontal component will be absorbed by the vapour for the frequency N, and its vertical component for the frequencies $N+n$ and $N-n$. The other components will be transmitted, and being vertical and horizontal respectively, and not being of the same period, they cannot be extinguished by a nicol set to quench light polarised at an angle a to the vertical. When the incident light is polarised in a vertical plane, however, or in a horizontal plane, the analysing nicol can quench the transmitted light, and the lines do not light up in the spectroscope. The writer has found on trial that the expectation of theory is realised, and that when the polariser is inclined to the vertical the phenomenon takes place across the lines of force as in Righi's experiment along the lines of force.[1]

Many other interesting points deserve notice, such as Prof. G. F. Fitzgerald's theory connecting the Faraday effect with the Zeeman effect; but want of space compels us to close the present account of the work done in this field during the past year. We may just mention, in conclusion, that the Faraday effect in gases has been placed in strong evidence by an interesting experiment due to MM. Macaluso and Corbino (*Comptes rendus*, t. 127, p. 548, 1898), which depends for its explanation on the fact that the rotatory power of a substance increases enormously as the frequency of the transmitted light approaches that of an absorption band of the substance through which it is transmitted.

THOMAS PRESTON.

RECENT WORK IN COMPARATIVE MYOLOGY.

THE introduction of biology into medical education, productive of such good effects, has been in few departments more beneficial than in that of comparative anatomy; and we desire to call attention to the present aspect of one outcome of this, which appears to us a direct result of the adoption by the surgical anatomist of the comparative method, and to be full of promise for the future.

Our remarks are prompted by a paper which has recently appeared in the *Proceedings* of the Zoological Society, as the completion of an extensive study of the comparative myology of the terrestrial carnivora, by Prof. Bertram Windle and Mr. F. G. Parsons, a most laborious piece of work, involving the careful dissection of close upon one hundred individuals representative of the leading carnivorous families. Of desultory descriptions of the myology of individual mammals we have long had enough, and it is the merit of the two anatomists named to have attacked the subject in a thoroughly systematic manner, transcending that of most of their predecessors. Incorporating with their own extensive observations the sum of our previous knowledge, by carefully classifying the muscles, dealing with them in sets, and tabulating their relationships where necessary in a manner permitting of ready reference, they have now laid the foundation of a really comprehensive system of recording myological facts. The paper to which we refer is serial with others which its authors have published on the Rodentia and Marsupialia, either individually or together; and perusal of the series leads us to believe that in finally deciding the zoological position of some of the more anomalous mammalian forms the study of the muscles may yet play a not unimportant part. We welcome thus, for example, the conclusion of one of the authors that the Jerboas are allied to the Myomorpha as insisted upon by Winge; and the fact that in other respects they are in agreement with his recent work in the classification of the Mammalia, the value and importance of which has been by no means sufficiently appreciated in this country.

In having access to the collections of the Zoological Society, Royal College of Surgeons Museum, and other London institutions, our authors command a wealth of material unobtainable elsewhere, and they are thus enabled not merely to record facts of adult anatomy, but, by comparing individuals of species, to approximately determine the limitations of individual variation. Accurate observations, when systematically arranged, have a permanent value in the progress of science; and, confessing to an admiration of the laborious persistence with which our authors have persevered in their task, we sincerely hope they will continue it until each and every order of Mammals shall have been investigated.

REV. BARTHOLOMEW PRICE, F.R.S.

THE death of the Rev. Bartholomew Price, F.R.S., on Thursday last, deprives the University of Oxford of one who worked long and loyally for its welfare. He took a most active part in the business of the University and of his College, and on many occasions helped to further the interests of science at Oxford. For these labours and for his attractive personal qualities he will be long remembered by many old pupils and friends.

Dr. Price was born in 1818 at Coln St. Dennis, Gloucestershire, and was educated privately at Pembroke College, whence he obtained a first class in mathematics in 1840. He gained the University Mathematical Scholarship in 1842, and two years later was elected Fellow of his College. In 1844 he became tutor, and nine years afterwards Sedleian Professor of Natural Philosophy. In 1852 appeared the first volume of his elaborate work on the infinitesimal calculus, dealing with the differential calculus; the second, on the integral calculus and calculus of variations, was published in 1854; the third, on statics and dynamics of a particle, appeared in 1856; and the last of the four, on the dynamics of material systems, was published in 1862. This treatise obtained for him a considerable reputation in the mathematical world; but his principal work in life was practical, and he will be remembered rather as the active secretary of the University Press during the years of its first great activities after the death of Dean Gaisford, than as a Mathematical Professor. Prof. Price resigned the secretaryship of the Clarendon Press in 1885, when he was succeeded by Mr. P. Lyttelton Gell, who held the post till a few months ago.

Dr. Price was appointed Sedleian professor of natural philosophy at Oxford in 1853, and he only retired from his post in June last, upon attaining his eightieth year. The event was commemorated by a dinner, at which numerous old pupils and others showed the esteem in which they held their counsellor and friend. For many years, both before and after his appointment to the chair of Natural Philosophy, the greater part of the mathematical teaching of the University was in his hands. He was one of the public examiners in mathematical and physical sciences eleven times in twenty-four years, and his works on the differential and integral calculus, &c., were for long the recognised text-books.

Dr. Price was elected a Fellow of the Royal Society in 1852, and he served on the Council of the Society no less than five times. He also served on the Royal Com-

[1] Prof. Righi's elegant experiment was brought before the notice of the British Association in September last by Prof. S. P. Thompson, and three or four days afterwards, with kind permission, I made the observations here described in Prof. Barrett's laboratory in the Royal College of Science, Dublin.

mission to inquire into property and incomes of the Universities of Oxford and Cambridge. He was a Curator of the Bodleian Library, an honorary Fellow of Queen's College, a member of the governing body of Winchester College, and a visitor of the Greenwich Observatory. He was appointed Master of Pembroke College in 1891.

By his remarkable diligence and geniality, and his services in furthering scientific interests at Oxford, Prof. Price became a distinguished feature of his University, where his death will be deeply regretted.

NOTES.

SCIENCE is to be congratulated that two well-known workers for its advancement are included in the list of New Year honours. We refer to Prof. W. C. Roberts-Austen, who has been promoted from the rank of Companion of the Order of the Bath (C.B.) to a Knight Commandership (K.C.B.), and Mr. W. T. Thiselton-Dyer, who has been raised to the rank of Knight Commander of the Order of St. Michael and St. George (K.C.M.G.). Two distinguished members of the medical profession have had honours conferred upon them—Sir Henry Thompson receiving the dignity of a baronetcy, and Dr. Hermann Weber the honour of knighthood. Mr. J. F. Flannery, ex-President of the Institute of Marine Engineers, has also been knighted.

THE recent retirement of Sir John Evans from the Treasurership of the Royal Society, after a period of service of twenty years, has given an opportunity for Fellows of the Society to show their appreciation of the efficient manner in which he discharged the duties of his office. It is proposed to have his portrait painted in oil colours, and to hang it on the walls of the Society's apartments at Burlington House. This would be an appropriate form of recognition of the long association of the Treasurer with the interests of the Society. A number of subscriptions have already been received, and any Fellows of the Society who wish to contribute should send their donations to the Assistant Secretary.

A TELEGRAM from Sydney has been received at the Royal Society stating that the boring into the coral at Funafuti had been discontinued on reaching a depth of 1114 feet. An account of recent operations at Funafuti appeared in NATURE of November 3, 1898 (p. 22).

AT St. Petersburg, last week, a Pan-Russian congress of climatology, hydrology, and balneology was opened by the Grand Duke Paul, as president of the Society for the Preservation of Public Health, for the discussion of means of improving and better utilising the health resorts, bathing places, and mineral waters which now abound in various parts of the empire, especially in the Crimea and the Caucasus.

THE French Government is about to adopt precautionary measures against the introduction of the San José scale into France. Decrees will be issued prohibiting the importation of trees, shrubs and plants from the United States, and requiring an inspection of all fruits, fresh and dried, at the point of landing in France.

THE death of Dr. John Stillwell Schanck, emeritus professor of chemistry and hygiene in Princeton University, is recorded in *Science*. Dr Schanck was born in 1817, and began the practice of medicine at Princeton in 1843. In 1847 he was made lecturer in zoology at the College, and in 1856 was elected professor of chemistry, to which the chair of natural history was added in 1869. In 1874 the professorship was limited to chemistry, and from 1885 until he was made emeritus professor, in 1892, his chair was entitled chemistry and hygiene.

M. MAURICE LÉVY has been elected Vice-President of the Paris Academy of Sciences for the current year, in succession to M. van Tiegham, who passes to the presidential fauteuil.

IN the report of the meeting of the Kent Coal Company (*Standard*, December 24), the Chairman is stated to have said that "if there was coal in Kent it must affect that Company for good. If there was not, then every scientific man had been wrong. He did not think that could be." The Dover boring has certainly proved the presence of coal-measures in Kent, but no scientific man can say how far these underground coal-measures extend.

THE *Electrical Review* announces that a competition has just been opened by the Swiss Society of Chemical Industry for a treatise which shall be of service in aiding the development of the electro-chemical industry in Switzerland. A premium of 2000 francs (80*l*.) is being offered to the author of the work which shall be adjudged the best of those sent in. All competitors must send in their work by May 1, 1900, to Herr Dr. Henry Schaeppi, president, Die Schweizerische Gesellschaft für Chemische Industrie, Mitlödi, Switzerland, from whom full particulars of the competition may be obtained.

IT is announced by the *British Medical Journal* that an international congress on tuberculosis and the methods for combating it will be held in Berlin from May 23 to 27. The Imperial Chancellor, Prince Hohenlohe, will preside, and will be supported by an influential Committee, headed by the Duke of Ratibon and Prof. von Leyden. Five divisions of the subject have been agreed on: (1) propagation, (2) etiology, (3) prophylaxis, (4) therapeutics, (5) sanatoria. Each of these questions will be introduced by a short and concise address, so as to leave ample time for free discussion and debate.

THE twenty-sixth annual dinner of old students of the Royal School of Mines will take place at the Hotel Cecil on Friday, January 27. The chair will be taken by Mr. F. W. Harbord. Tickets may be obtained from Mr. H. G. Graves, 5 Robert Street, Adelphi, London, W.C.

MR. G. E. LUMSDEN informs us that he has been asked by the President of the Astronomical and Physical Society of Toronto to collect such confirmatory data as are accessible in respect of the contention that associated with certain lightning-flashes and displays of aurora, there are black or dark phenomena. He would be glad to obtain evidence upon this subject, and would be prepared to purchase, if necessary, photographs or lantern slides of lightning flashes, where black streaks or other phenomena are undoubtedly present. His address is The Parliament Buildings, Toronto, Canada.

SOME interesting facts with reference to the mining and minting of gold and silver are mentioned by Mr. Alexander E. Outerbridge, jun., in a paper published in the December *Journal* of the Franklin Institute. It is remarked that notwithstanding the excitement over the Klondike discoveries, the output from that region is insignificant when compared with the total product of the whole country. Statistics show that the State of Colorado alone added twice as much gold to the world's stock in 1897 as did the Klondike region, and several other States largely exceeded the Klondike output. As to the South African gold fields, American mining engineers who have been engaged in developing them, have computed from surveys of the ground and numerous assays of samples of ore taken from different localities and at different depths, that the gold contained in the ore in sight in the district known as the "Rand," or Witwaatersrand, amounts to the enormous value approximately of 800,000,000*l*., and at the present rate of production it will take half a century to exhaust these deposits, even though no further discoveries be made. Australasia and the

United States together produced more than one-half of the entire output of gold in 1897, and it is in these two countries that modern methods have been most largely adopted.

The Decimal Association has taken a leading part in educating public opinion, and in making known the advantages of the metric system. The system is used so extensively in scientific work that it is unnecessary to explain in these columns its claims for adoption. The strongest argument in favour of metric weights and measures is the fact that nearly all the leading civilised countries of the world, as well as nearly all our competitors in foreign trade, use them exclusively. From a table given in a pamphlet published by the Decimal Association, it appears that the countries which have already adopted the metric weights and measures represent a population of over 448 millions. Our consuls have almost unanimously reported in favour of the system; our chief Chambers of Commerce have passed resolutions in favour of it; in the new "British Pharmacopœia" the use of the system has been much extended; and numerous trade associations have given support to it; while in no single case has any body of wholesale or retail traders opposed its compulsory adoption. It is now especially urgent that an Act should be passed to make the change compulsory, and all who are interested in this important question are urged to become members of the Decimal Association, and to give it the benefit of their influence and co-operation. The Secretary is Mr. Edward Johnson, Botolph House, Eastcheap, London, E.C.

Reference has been made in these columns on several occasions to Prof. Grassi's work in tracing the propagation of malarial germs by mosquitoes. Further information is now brought to light by communications read before the Reale Accademia dei Lincei during the past month, and published in their *Atti*, vii. 9 and 11. Messrs. G. Bastianelli, A. Bignami and Grassi have now succeeded in tracing the development of the semilunar bodies in the medial intestine of *Anopheles claviger*, kept at a suitable temperature, after these insects had drawn blood from individuals affected by æstivo-autumnal malaria. They have also obtained spring fever by the sole agency of punctures of *A. claviger* in an individual not previously afflicted by malaria and living in a non-malarial locality. Most recently they have observed the later stages of the semilunar bodies in *A. claviger*, and have obtained capsules containing an enormous quantity of filiform bodies apparently non-motile, with one or two amorphous residual masses. The life-history of the malarial parasite is thus proved to be an authenticated case of heterœcism. Concurrently with these observations, Dr. Antonio Dionisi has studied the life-cycle of the endoglobular parasite of the bat, which appears to undergo a similar alternation of generations, the intermediary host being an insect. These conclusions agree with Ross's investigations on the malarial parasites of birds.

The discussion of the meteorological observations recorded at Trevandrum, under the superintendence of Mr. J. Allan Broun, during the years 1853 to 1864, is published in vol. x. part i. of the *Indian Meteorological Memoirs*. The observatory, which was established by the Maharajah of Travancore, was situated approximately in latitude 8° 31′ N., longitude 76° 59′ E. The observations were deposited at the Meteorological Office in London, and the Meteorological Council, recognising the high scientific value of the data, requested the Secretary of State for India, through the Royal Society, to undertake their discussion, which was agreed to, and the work has been ably carried out under the supervision of Mr. J. Eliot, Meteorological Reporter to the Government of India. We can only very briefly refer to a few of the valuable results obtained. The highest temperature observed was 94°·6, in March, and the lowest 59°·9, in December, giving a total range of 34°·7. The highest and lowest mean daily temperatures were 84°·5 and 70°·9, and the highest and lowest mean monthly temperatures were 82°·9 and 75° respectively. The greatest change in twenty-four hours was 5°·1, in May. One of the most noteworthy features of the meteorology of Trevandrum is the remarkable steadiness of barometric pressure; it is highest from January 11–15 (29·731″), it decreases slowly, but steadily, until the end of May, when it is 29·621″, and it increases during the remainder of the year. The absolute maximum of the diurnal range is ·132″, in February, and the absolute minimum ·099″, in July. The relative humidity is large in all months, varying from a minimum of 72·6, in February, to 86·8, in July. The annual rainfall varies considerably; the mean for thirty-nine years (1838 to 1876) is 64·4″. The mean for the three years of greatest fall was 27·7″ more, and the mean for the three years of least fall was 25·8″ less than the mean fall.

We have received a valuable quarto memoir by P. Jose Coronas, of the Manila Observatory, on the eruption of the volcano Mayon, which occurred on June 25–26, 1897. Mayon is the largest volcano in the island of Luzon, and a brief account is given of the principal known eruptions prior to 1897; but, with three exceptions (those of 1616, 1766 and 1800), these all belong to the present century. In a series of interesting chapters, Father Coronas describes the preparatory phenomena (including the earthquake of May 13), the beginning of the eruption, the ejection of lava, the rain of ashes and dust (which extended to about one hundred miles east of the volcano), the detonations and other subterranean noises, the storm on the volcano, and the end of the eruption. The memoir is issued from the private press of the observatory, and is illustrated by four plates and three figures in the text.

The native arithmetic of Murray Islands, Torres Strait, is described by the Rev. A. E. Hunt in the latest *Journal* (New Series, vol. i. Nos. 1 and 2) of the Anthropological Institute. The only native numerals are netat (one) and neis (two). Higher numbers would be described either by reduplication, as neis netat, literally, two-one for three; neis-i-neis, or two-two for four, &c., or by reference to some part of the body. By the latter method a total of thirty-one could be counted. The counting commenced at the little finger of the left hand, thence counting the digits, wrist, elbow, armpit, shoulder, hollow above the clavicle, thorax, and thence in reverse order down the right arm, ending with little finger of right hand. This gives twenty-one. The toes are then resorted to, and these give ten more. Beyond this number the term gaire (many) would be used. English numerals are now in general use in the Islands.

The Chinch Bug (*Blissus leucopterus*, Say), one of the most destructive of North American insects, forms the subject of *Bulletin* No. 15 (New Series) of the U.S. Department of Agriculture, Division of Entomology. A previous report on the same subject, by Dr. L. O. Howard, was published as No. 17 of the Old Series of the *Bulletin*: the present has been prepared and brought up to date by Prof. F. M. Webster, the entomologist of the Ohio Agricultural Experiment Station, under Dr. Howard's supervision. The Report deals with the probable origin, diffusion and habits of the insect, with notices of the natural checks to its increase, and the remedial and preventive measures which may be used against it. The Report also includes a notice of various American *Hemiptera* which are likely to be mistaken for the Chinch Bug; and of an allied species (*Blissus doriae*, Ferr.) which occcurs in Italy and Hungary.

Dr. G. Christian Hoffmann sends a report of the Section of Chemistry and Mineralogy of the Geological Survey of Canada. Aided by two assistants, Mr. F. G. Wait and Mr.

R. A. A. Johnston, analyses have been made of coals and lignites, of various minerals, ores, rocks, and waters. Among the minerals, there is one named Baddeckite, a new variety of Muscovite, found at Baddeck, Victoria Co., Nova Scotia. It is a hydro-muscovite, in which a very large proportion of the alumina is replaced by ferric oxide. The occurrence in Canada of Chalcanthite and Xenotime are for the first time recorded. An analysis of a spring-water on Cañon Creek, in Alaska, proved the presence of 266 grains of mineral matter—chiefly salts of lime and magnesia.

THE Devonian fossils of Canada have for many years been a subject of special study by Mr. J. F. Whiteaves, palæontologist to the Geological Survey of Canada. In the concluding part of the first volume of "Contributions to Canadian Palæontology," Mr. Whiteaves describes some additional or imperfectly understood fossils from the Hamilton formation of Ontario. These include some supposed Cliona-borings, Corals, Crinoids, Polyzoa, Mollusca, Crustacea and Fishes. Mr. Whiteaves adds a revised list of all the known fossils from the Hamilton formation. Of these, *Atrypa reticularis* appears to be the only well-known European species. The Fishes include *Ptyctodus* and *Aspidichthys*.

MR. JOHN H. SCHAFFNER, of the Ohio State University, writing in the *Journal of Applied Microscopy*, recommends the use of anilin safranin and gentian violet as affording a very good and durable stain for starch grains.

FROM Prof. Jamshedji Edalji we have received papers on "Reciprocal Polygons" and "Associated Conics," in which many well-known theorems and other less-known properties of conics are proved, the method of reciprocation being largely used. The properties of ellipses touching a pair of conjugate hyperbolas afford interesting exercises, but we could wish that the text and figures were rather better printed.

MESSRS. G. W. BACON AND CO., LTD., have just published a well-coloured wall diagram of common poisonous plants. The pictures of the foxglove, woody nightshade, and monkshood are particularly good. The chart should be very useful in country schools to familiarise children with the plants to be avoided.

PROF. MANDEL'S translation of Prof. Hammarsten's "Text-book of Physiological Chemistry" was reviewed in these columns four years ago (vol. l. p. 449). A second American edition, prepared from the third revised German edition by the same translator, who produced an excellent English version of the earlier one, has now been published by Messrs. John Wiley and Sons. The new volume is essentially the same as the first edition, being simply brought up to date.

A COPY of the first number of *Science Work*—a monthly review of scientific literature—has been received. The contents consist of a few general notes, the titles of a selection of articles which have recently appeared in some periodicals, a directory of lecturers, and a synopsis of some scientific expeditions now in the field. The publishers of this venture are Messrs. Robert Aikman and Co., Manchester.

WE have received a copy of a pamphlet entitled "Replica di Krupp alla Protesta del Signor Bashford," published by the Cambridge University Press. In the *Revista di Artiglierca e Genio*, Dr. Bashforth charged the Krupp firm with making use of his general tables of velocity and time, and velocity and space, containing the results of his experiments, without acknowledgment. Mr. F. Krupp has replied on behalf of the firm, and the pamphlet now received contains a translation of this letter presenting the Krupp view of the matter, with an introduction and notes by Dr. Bashforth, which he holds afford ample justification for his protest.

THE last two parts received (Heft 3 and 4) of Engler's *Botanische Jahrbücher fur Systematik, Pflanzengeschichte, u. Pflanzengeographie* contain the following articles:—The conclusion of Hieronymus's account of the Pteridophyta of Argentina; Anderson on the History of the Vegetation of Sweden; Höck on the Flora of the alder-plantations of North Germany; Fedtsckenko on the Flora of the southern Altai mountains; a continuation of Pfitzer's Classification of the Orchideæ; the commencement of a paper by Perkins on the Monimiaceæ; and a description by Hallier of *Hildebrandtia*, a new diœcious genus of Convolvulaceæ.

THE number of new syntheses capable of being carried out with the aid of diazomethane, would appear to be by no means exhausted. Prof. H. von Pechmann describes in the current number of the *Berichte* a new synthesis of pyrazol by means of this active reagent. A solution of diazomethane in ether is cooled to 0° C. and saturated with dry acetylene in a large flask, and the whole allowed to stand. The reaction is rather slow, about two days being required; simple evaporation then deposits pure pyrazol in fine prisms in quantity about fifty per cent. of the theoretical value.

THE announcement is made (by M. and Mme. Curie and M. Bémont), in the current number of the *Comptes rendus*, of the probable existence of a new element, to which the name of radium is provisionally given. It will be remembered that M. Becquerel discovered that the metal uranium and its salts possessed the remarkable property of emitting rays much resembling the X-rays in penetrative power and action upon electrified gases. Using this new weapon of research, M. and Mme. Curie were able to isolate from pitchblende a new element (*polonium*) resembling zinc in its chemical properties, differing from this metal, however, in possessing radio-active properties of a similar character to uranium, but of greater intensity. In following up this work they (in conjunction with M. Bémont) have now obtained indications of another element possessing still more powerful radio-active properties, and chemically resembling barium, inasmuch as it is precipitated neither by sulphuretted hydrogen, by ammonium sulphide, nor by ammonia; the sulphate is insoluble in water and in acids; the carbonate insoluble in water; and the chloride, although very soluble in water, insoluble in alcohol. Fractional precipitation of the chlorides by alcohol showed an increasing amount of radium in the precipitate, as measured by its radio-activity, the final fractions possessing an activity 900 times greater than uranium. The spectrum of this chloride was found by M. Demarcay to give, besides the lines of barium, lead, calcium and platinum, a strong new line ($\lambda = 3814{\cdot}8$), which in his opinion confirms the existence of a new element.

IN a recent number of the *Proceedings* of the American Academy of Arts and Sciences, Prof. T. W. Richards, of Harvard, describes a series of interesting experiments on the retention and release of gases occluded by the oxides of metals, a subject of special importance to those engaged in the determination of atomic weights. He shows that oxide of copper prepared by ignition of the nitrate contains between four and five times its volume of occluded gases up to a temperature of 860° C. Slightly above this temperature the bulk of the gas is given off, but before 1000 is reached the copper oxide itself decomposes. Of the gases resulting from the decomposition of the nitrate, the oxygen escapes more rapidly than the nitrogen. The explanation given by Prof. Richards is that the gases proceed from basic nitrate imprisoned in the oxide, the N_2O_5 being resolved into nitrogen and oxygen. The oxygen escapes more rapidly than the nitrogen, by uniting with metal or a lower oxide which has momentarily released some of its proper supply of oxygen. The released oxygen passes onwards and

outwards by a similar process, so that there is a continuous transference of oxygen by a sort of Grotthus chain of unstable copper oxide molecules. This view is in harmony with the fact that cupric oxide, the most easily reducible of the oxides investigated, is the one which parts with its occluded oxygen most easily, at the same time obstinately retaining the nitrogen, whilst the oxides of zinc and magnesium, being more stable, retain the oxygen persistently. It was found that the electrical conductivity of copper oxide was much increased at a temperature approaching redness, whilst that of zinc oxide was much less increased, and that of magnesium oxide not at all. This would be explained by the copper oxide being to a certain extent dissociated by heat, and permitting of some metallic conduction. Cupric oxide was found to give up oxygen steadily when heated in vacuo to 790°, cuprous oxide being found in the residue.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. A. Urban Smith; six Snow Buntings (*Plectrophanax nivalis*), European, purchased; three Grey Squirrels (*Sciurus cinereus*) from North America, deposited; a Great Eagle Owl (*Bubo maximus*), bred in the Gardens.

Errata.—In the necrology of Prof. Allman, p. 202, line 18, delete "Regius"; p. 204, line 37, for "Grumera" read "Gunnera."

OUR ASTRONOMICAL COLUMN.

COMET CHASE.—The following ephemeris of Comet Chase is a continuation of that which we have previously published from Herr J. Möller's computation:—

1899.	R.A. (app.) h. m. s.	Decl (app.) ° ′	Br.
Jan. 1	11 5 50	+29 23·5	1
7	6 45	29 46·1	1
9	7 33	30 8·7	1
11	8 14	30 31·5	1
13	8 48	30 54·6	1
15	11 9 15	+31 17·9	1

PLANET WITT (DQ 1898).—Although only of the twelfth magnitude, planet Witt should be closely followed and good positions measured as opportunities afford. The accompanying ephemeris for the coming fortnight will prove useful to those whose instruments are large enough to follow this interesting body.

Berlin Midnight.

1898.	R.A. h. m. s.	Dec. ° ′
Jan. 5	23 3 0	+4 37·6
7	7 51	5 3·3
9	12 45	5 29·6
11	17 42	5 56·1
13	22 44	6 23·0
15	27 48	6 50·2
17	32 56	7 17·7
19	23 38 6	+7 45·4

The above ephemeris, calculated by Dr. E. Millosevich (*Astr. Nachr.*, 3532), requires, according to an observation by Dr. Cerulli, a correction of about - 5s. in R A., and - 0′·3 in declination.

ASTRONOMICAL PHOTOGRAPHY WITH SMALL INSTRUMENTS.—The earnest worker, even with only small means at his disposal, may perform important work in astronomy by the aid of lenses of comparatively small aperture. The great advances made in the sensitiveness of dry plates helps us now to photograph quite easily objects which formerly presented a great difficulty.

By replacing the eyepiece of a good telescope with a small camera, with a suitable positive or negative lens, very useful work can be done, although the scale of magnification need not be very great. The employment of a negative lens makes the instrument more convenient for use, as a shorter telescope tube can be utilised.

One great function of photographs of celestial objects is to record changes in the appearance of bodies or regions studied. In the case of the former large images are required, and the photo-telescopes are the most suitable; in the latter, large fields, but not necessarily very large magnification, are required for many purposes of great interest. In the *Photographische Correspondenz*, Herr P. Zschokke points out in an interesting article the useful work an amateur can accomplish by means of small instruments, and gives an interesting table showing the relative sizes of apertures, focal lengths of objectives, focal lengths of combinations, &c. Since, in this class of instrument, the size of the diameter of the image formed is the main point, we give below the table containing these values, which has been reproduced in the *British Journal of Photography* (December 23, 1898). All the figures in the following columns refer to millimetres.

Aperture.	Focus of objective.	Focus of tele-photo combination.	Entire length of telescope.	Diameter of image of sun or moon.
61	730	5370	980	50
81	1218	8060	1350	75
108	1624	11370	1960	108
135	1949	16115	2365	150
135	1353	16115	1800	150
162	2599	32230	3510	300
162	2599	24170	3155	225

A NEW VARIABLE IN CASSIOPEIA.—Dr. T. D. Anderson, writing in the *Astr. Nachr.* (No. 3533), states that the star which has the position for 1855, R.A. 23h. 37·5m., and Decl. + 55° 45′, is a hitherto unnoticed variable. This star, which is not recorded in the BD, was first seen by Dr. Anderson in the beginning of 1897, and was then only 0·2 magnitudes fainter than + 55°·3007, the magnitude of which was then fairly estimated as 9·0. In September 23 of the same year the star was found missing, although another star of magnitude 10·3 could be easily seen 3′ to the north of the missing star. Subsequent searches failed to pick up the same star again; and Dr. Anderson, coming to the conclusion that the object was probably a Nova, only examined the region very occasionally.

Last month, however, on the 5th, he again examined the region, and at last found the object of his search. At this time it excelled in brilliancy its neighbour of magnitude 10·3 by as much as it was itself surpassed by BD + 55°·3007.

OBSERVATIONS OF α ORIONIS.—Mr. R. T. A. Innes, writing from the Cape Observatory (*Astr. Nachr.*, 3533), mentions that he has been observing α Orionis (Betelgeuze) on several evenings, and the star was found to be only slightly brighter than Aldebaran. Last season, as Mr. Innes states, Betelgeuze was twice as bright as Aldebaran, which is its ordinary state. From this observation it may be concluded that one of the irregular minima of Betelgeuze is approaching.

PRIZES PROPOSED BY THE PARIS ACADEMY OF SCIENCES FOR 1899.

THE following are the prize subjects proposed by the French Academy of Sciences for the present year.

The Bordin Prize (3000 fr.) for a study of the questions relating to the determination, properties, and application of systems of orthogonal curvilinear coordinates of n variables, indicating particularly, in as precise a manner as possible, the degree of generality of these systems; the Francœur Prize (1000 fr.) and the Poncelet Prize (2000 fr.), for useful work in the field of pure and applied mathematics. In Mechanics is offered the Extraordinary Prize of 6000 francs, for any invention increasing the efficiency of the French naval forces; the Montyon Prize (700 fr.), for the invention or improvement of instruments useful to the progress of agriculture or the mechanical arts; the Plumey Prize (2500 fr.), for any invention contributing to the progress of steam navigation; the Tourneyron Prize, for an improvement in any point of the theory of pumps. In Astronomy, the Lalande Prize (540 fr.), for the most interesting or useful astronomical observation made during the year: the Valz Prize (460 fr.) for astrononomical work. In Physics, the La Caze Prize (10,000 fr.). In Statistics, the Montyon Prize (500 fr.). In Chemistry, the Jecker Prize (10,000 fr.) for discoveries in organic chemistry; the Cahours Prize (3000 fr.) for the encouragement of research in young chemists already known by their published work; and a La Caze Prize of 10,000 fr. In Mineralogy and Geology, the Delesse Prize (1400 fr.), and the

Fontannes Prize (2000 fr.) for researches in palæontology. In Biology, the *Grand Prix* of the Physical Sciences (3000 fr.) for a study of the biology of Nematods, especially the forms and conditions of their reproduction, and the Bordin Prize (3000 fr.). In Botany, the Desmazières Prize (1600 fr.) for work on the Cryptogams; the Montagne Prizes (1000 fr. and 500 fr.) for important work bearing on the anatomy, physiology, development, or description of the lower Cryptogams; and the Thore Prize (200 fr.) for the best memoir on the cellular Cryptogams of Europe. In Anatomy and Zoology, the Savigny Prize (975 fr.) for the assistance of young travelling zoologists. In Medicine and Surgery, a Montyon Prize for discoveries or inventions having a direct bearing upon the art of healing; the Barbier Prize (2000 fr.) for similar objects; the Bréant Prize (100,000 fr.) for the discovery of an absolute specific against Asiatic cholera; the Godard Prize (1000 fr.) for the best memoir on the anatomy, physiology, and pathology of the genito-urinary organs; the Serres Prize for a memoir on general embryology applied as far as possible to Physiology and Medicine; the Chaussier Prize (10,000 fr.) for the best book or memoir which has appeared during the last four years, either in medicine, legal or practical medicine; the Bellion Prize (1400 fr.); the Mège Prize (300 fr.); the Lallemand Prize (1800 fr.) for work on the nervous system; and the Baron Larrey Prize (1000 fr.) for a memoir on military or naval medicine, surgery, or hygiene. In Physiology, a Montyon Prize (750 fr.); a La Caze Prize (10,000 fr.); the Pourat Prize (1400 fr.) for a memoir on the specific characters of the contraction of different muscles; and the Philipeaux Prize (890 fr.) for work in experimental physiology. In Physical Geography, the Gay Prize (2500 fr.) for a study of the Mediterranean mollusca, and a comparison of these with those found on the French oceanic coasts.

Other general prizes offered for 1899 include the Arago Medal, the Montyon Prize (unhealthy trades), the Trémont Prize (1100 fr.), the Gegner Prize (4000 fr.), the Petit D'Ormoy Prizes (10,000 fr. each), one for work done in mathematics, and the other in natural science; the Leconte Prize (50,000 fr.), the Tchihatchef Prize (3000 fr.), the Gaston Planté Prize (3000 fr.), the Houllevigue Prize (500 fr.), the Wilde Prize (4000 fr.), the Saintour Prize (3000 fr.), the Kastner-Boursault Prize (2000 fr.), the Jean-Jacques Berger Prize (12,000 fr.), and the Baron Joest Prize (2000 fr.).

Of these the prizes bearing the names of Wilde, Tchihatchef, Leconte, Desmazières, Delesse, La Caze, and Lalande are expressly stated to be offered without distinction of nationality.

MAGNETIC SURVEYS.[1]

THE importance of magnetic survey work has been recognised for a long time. Many of the most eminent scientific men of the century now about to close have devoted much time and thought to magnetic observation and the reduction of results, and their labours have not been without fruit. To them we owe all that is known with certainty as to the magnetic state of the earth and its changes; and though observations have no doubt to some degree outpaced the work of reduction and the construction of theory, much has been done to construct from observational data a general theory of terrestrial magnetism. We have the great mathematical theory of Gauss based on the results of Sabine, Barlow, Horner, and others, with the answer it gives to the question of the locality of the magnetic distribution which gives rise to the ordinary phenomena of terrestrial magnetism. Also, and founded to some extent on Gauss's theory, we have now that of Schuster on the daily changes of the magnetic forces and their causes, which has yielded most important results, as to the locality of the sources of this periodic disturbance. As a consequence of Schuster's theory there have lately been published some important discussions of the diurnal changes and their theory by von Bezold and others.

The secular changes have received a great accession of interest since Bauer's first discussion of the subject some years ago in an inaugural dissertation at the University of Berlin. In that he gave the method of graphical representation of the secular changes now known by his name. An observer is supposed to look from the centre of a magnet, freely suspended at its centre of gravity, and to note the curve which the north-pointing pole seems to describe, and which shows changes of dip as well as changes of magnetic declination. This mode of representation can, of course, be applied to the diurnal changes, and shows that though a complete cycle of secular changes is not yet available from observations, yet the diagram of the diurnal changes may serve to complete it. Let the secular changes be produced by the combination with a constant magnetic system rotating with the earth of a second system, also turning with the earth, but while doing so describing a secular orbit round the earth's axis. This is the hypothesis of Wilde. Now let a needle be imagined suspended outside the earth while the earth turns beneath it. The superimposed magnetic system will in the course of one rotation of the earth occupy the same position relatively to the suspended needle that it successively occupies in the secular period with reference to a needle fixed with the earth and turning with it. The curve thus obtained for a single day will, if the second system be invariable and its successive positions be symmetrical about the earth's axis, be the same as the secular curve. Though this curve cannot be directly observed, for no needle can be suspended in the manner supposed, the distribution of magnetic force round the earth is sufficiently well known to enable the positions of the needle to be calculated and the curve laid down on paper. The indications at the same instant of time of needles suspended at different points of the same astronomical circle of latitude, in fact, give the curve. There is sufficient similarity between the curves obtained in this way[1] to afford a fairly satisfactory first test of Wilde's hypothesis, and no doubt further progress in the solution of this interesting question will shortly be obtained by Dr. Bauer himself, or others.

The origin of the diurnal and secular variations may perhaps become known fully only when the secret of terrestrial magnetism itself is revealed. In the meantime there can be no question of the absorbing interest of the problem, and of the fact that the only way to solve it is by means of continued magnetic observation at different parts of the world, at sufficiently equipped and properly chosen magnetic observatories. It is to be hoped that as the value of observations, so far as the secular changes are concerned, depends on their comparison with those obtained much later in time, care will be taken in future by municipal and government authorities not to injure or render nugatory the work done by bringing disturbing electric currents and traffic into the vicinity of observatories. The fact that a sub-section (of Section A) of the British Association gave itself at the recent meeting to the discussion of terrestrial magnetic problems is at once an indication of fuller recognition of the interesting nature and the importance of magnetic research, and a guarantee that magnetic observatories and laboratories will be made to co-operate to the best advantage in the work to be done, and that everything will be done to induce authorities to protect them when powers are being sought for engineering projects.

Dr. Bauer has set before us a brief but interesting statement of the history of magnetic research, the objects to be served by it, the kind of survey work that may be attempted best by observers in different localities, and the mode in which it should be carried out, illustrated by an account of a survey of part of the State of Maryland which he has lately undertaken.

There are many notes of great interest in this historical sketch. For example we find, what we confess we did not know before, that the discoverer of the declination of the compass needle from the true north was Christopher Columbus. It seems that on September 13, 1492, Columbus crossed the agonic line, the line of no declination, a little to the west of the Island of Fayal in the Azores, and observed that the compass at places on the east of this line pointed east, and at places on the west pointed west of the true north. This line ran, curiously enough, along the old boundary between the kingdoms of Portugal and Castile. Generally Columbus has received credit only for discovering the agonic line, owing to a statement of Formaleoni, the Italian historian, that Bianco's chart of 1436 contained values of the declination, an error which Humboldt perpetuated by repeating in his "Cosmos." The recorded value of the magnetic declination at Rome in 1269, ascribed to Petrus Peregrinus, was inserted, it appears, by some one early in the sixteenth century, thus subsequent to Columbus.

That the declination had not been discovered sooner arose

[1] "Maryland Geological Survey: First Report upon Magnetic Work in Maryland, including the History and Objects of Magnetic Surveys." By L. A. Bauer. Special Publication, Vol. I., Part V. Pp. v + 125, with one plate. (Baltimore: The Johns Hopkins Press, 1897.)

[1] See Prof. Rücker's Rede Lecture, NATURE, December 23, 1897.

from the fact that it was but small over the greater part of the Mediterranean, and so for long the deep-sea sailors of Europe were without much experience of its effects. When it did force itself on their notice it was supposed to be due to an error of construction, and a correction was made so that the point marked north on the card pointed to the astronomical north.

The importance of Gilbert's "De Magnete" has only been fully seen in the light of modern magnetic research. It constituted in itself an advance which has not been equalled by any single step during the three hundred years that have elapsed since its publication. So far as observation and theory have yet gone, even with the aid of Gauss's refined analysis, they have only confirmed the conclusion there set forth, *Magnus magnes ipse est globus terrestris*—"the earth is a great magnet." It is of great importance to decide whether or not the earth is a permanent magnet like a piece of steel, but the decision that its magnetism is induced by currents of electricity will not in any way contradict Gilbert's assertion.

Magnetic survey work has of course its own practical and commercial importance, but in a country like America, where public and private boundaries have been laid down by the compass, the determination of the secular variation is of peculiar interest. Without it the results of early land surveys could not now be interpreted.

In all cases the earlier surveys in America were compass surveys, and the directions referred to the magnetic meridian. Hence, as the deviation of the magnetic from the true meridian was known only in a few cases, the directions laid down in old topographical maps and plans of estates can only be recovered by determining the deviations now, and applying the known value of the secular variation. And Dr. Bauer says that one of the Eastern states actually still retains the magnetic meridian as the legal meridian of reference for land surveys. We had thought that such conservatism was unknown on the other side of the Atlantic.

Dr. Bauer quotes Robert Norman's own account of his discovery of the dip.[1] It has been quoted before, but not many have seen it, so we venture here to make a short extract. After stating that he had repeatedly found needles which had been finished and balanced before magnetisation inclining themselves to the horizontal with the north pole down when magnetised by being stroked with a lodestone, so that he had to "put some small piece of wire on the south point, and make it equall againe," but had put the result down to defect of construction rather than to "anie such propertie in the stone," he goes on: "It chaunced at length that there came to my hands an instrument to be made with a needle of sixe inches long, which needle after I had polished, cut of a just length, and made it stand levell upon a pin, so that nothing rested but onlie the touching it with the stone; when I had touched the same, presentlie the north part thereof declined down in such sort that being constrained to cut awaie some of that part to make it equall againe, in the end I cut it too short, and so spoiled the needle wherein I had taken so much paines. Hereby being stroken into some cholar, I applied myself to seeke further into this effect. . . ."

The first systematic surveys were made by William Whiston, better known perhaps as the translator of "Josephus." He was active in carrying on magnetic observations with a view to the determination magnetically of geographical position, and first drew isoclinics, made relative intensity observations, and invented the vibration method of obtaining the dip. His main object was to obtain the prize offered for the best solution of the problem of determining the longitude at sea, and he seems to have been successful in enlisting the interest of the Court, and even in obtaining money grants in aid of his work. Although the problem of the longitude was to be quite otherwise solved, Whiston's researches were of very great value. From Whiston to Gauss is a hundred years, but the next great development in terrestrial magnetic science came when Gauss introduced absolute measurement, and thus led observers to express results in units independent of arbitrary constants, so that they were at once available as data for other investigators. As a result the science has gone on vigorously from then till now developing in interest and importance. This, of course, is only one part of the effect of Gauss's work: it has been equally, if not more, productive of progress in the science of pure and applied electricity.

With respect to the conduct of magnetic survey work generally, Dr. Bauer makes some remarks which it would be well if observers would bear in mind. Much time and labour has been practically lost by the observation of only a single element, such as the declination. As he says, fully 75 per cent. of the time and money spent on a survey is spent in *occupying* stations, and the remainder only in observation. Thus it is only a very little further expense comparatively for an observer to observe a little longer, and get with sufficient accuracy values of all three elements. Thus magnetic declination surveys are of little value by themselves, except for the land surveying application, and those which have been carried out in many places could have been rendered many times more valuable to science by a very trifling additional outlay.

The initiation of terrestrial magnetic work by the British Association, the magnetic surveys carried out in this country by the British Association, and described in Sir Edward Sabine's Report for 1861, the more recent elaborate surveys by Thorpe and Rücker, and the work done in other parts of the world, are all appreciatively referred to.

Now that the British Association has again taken up the work in a very special manner, and a magnetic committee has been appointed, we may confidently expect to see a further great development of the subject. The work done by the conference at Bristol, under the presidency of Prof. Rücker, is a valuable instalment.

A. GRAY.

[1] From his book, "The New Attractive," &c., 1576.

PROGRESSIVE EDUCATION.[1]

THE publication of the second and third volumes of the series of reports prepared for the Education Department under the supervision of Mr. Michael E. Sadler, the Director of Special Inquiries, again calls the attention of educationists to the value of the work which is being performed by this latest addition to our national machinery for the guidance and coordination of educational effort. These reports, with their predecessors, closely resemble in their scope the publications of the U.S. Bureau of Education, and accentuate the fact that we have only lately commenced to do what has been for some time the established custom in the States. Just as the man of science acquaints himself with the work, failures and successes alike, of previous investigators in the field of his own activity, so to do the best possible work, the teacher, who is also an experimenter, should similarly become familiar with what has been accomplished by other teachers in different parts of the world. With these reports to hand, and others which will doubtless follow, there is no reason why the schoolmaster should not, in the future, start the education of his pupils armed with the experience of many successful veterans.

Though every one of the 1389 pages included in these volumes contains something of interest, this article is to be concerned more especially with what there is to be learnt concerning the present state of the teaching of science—whether in this country or abroad. Of the many plans of treatment which suggest themselves, perhaps, as reference to the volumes will be thereby facilitated, it will be best to take the papers containing important allusions to scientific instruction in the order in which they occur in the volumes themselves.

THE LONDON POLYTECHNIC INSTITUTES.

The London Polytechnic has but little resemblance to the institutions to which a similar name is applied in France, Switzerland, and Germany. Each Polytechnic Institute (of which there are at present eleven, with four branches) is an independent organisation which deliberately combines social intercourse, recreation, and instruction. As educational institutions these polytechnics constitute a new and distinct type; they range from the "Upper Standard" day school for boys and girls of thirteen, up to high University instruction and post-graduate research. All kinds and grades of work go on simultaneously. In one room boys of twelve are learning arithmetic, or girls of thirteen are being taught to sew; in another, classes of plumbers or bricklayers, compositors or tailors, are being practically trained in the processes of their respective crafts; close by is the smithy or the fitting shop, crowded with young engineering artisans; in other class-rooms are groups reading Dante or studying economics; and just at hand are well-equipped physical and chemical laboratories where

[1] "Special Reports on Educational Subjects." Vols. ii. and iii. (Issued by the Education Department, 1898.)

(as at Battersea this year) the teacher with a selected band of students is working out a Royal Society grant for research, or (as at Chelsea) graduates of more than one University are preparing their theses for the doctor's degree.

Six of the polytechnics now possess day schools and these have together about 1600 pupils, who are chiefly between twelve and fifteen years of age. Two of them are mixed schools for boys and girls, one has separate departments for the sexes, and three are confined to boys. They are in the main to be regarded as technical continuation schools. Seven day schools of a special type—the Domestic Economy School—are also attached to various polytechnics. In these the whole time of the pupil is spent in the study and practice of cookery, dressmaking, plain needlework, laundry work, and housewifery, with some elementary lessons in the chemistry of food and the physiology of hygiene. At Chelsea there is also a training school for servants.

At least 5000 workmen are at present attending the trade classes in connection with the London polytechnics. Not only is there a class in each branch of the building, engineering and metal, furniture, book and printing, and clothing trades, but also in such miscellaneous trades as baking, basket-making, and gas manufacture.

One polytechnic after another has found itself pushed into providing day instruction of various kinds, by the demand of students for whom evening classes are inaccessible or unnecessary. Thus the Battersea Polytechnic has regular day courses in mathematics and science, building and machine construction, wood-work and metal-work. The East London Technical College and the Regent Street Polytechnic have each a regular day engineering department, which turns out fully equipped engineers and electricians. At Regent Street a day architectural school has just been added. The Birkbeck Institution has a rapidly growing day department in natural science, including systematic courses in physics, chemistry, and biology. There are also day classes in Latin, Greek, and French, up to the standard of the B.A. degree of London University. At Chelsea there is a fully developed Technical Day College for men and another for women.

More than one provincial city, proud of its "University College," counts fewer systematic day students than a single London Polytechnic.

In the science laboratories of the polytechnics every attempt is made to render the instruction both practical and scientific, and in addition to the crowds of elementary pupils there is generally a small body of enthusiastic advanced students who spend every hour they can spare in the laboratory, carrying on original research under the personal direction of the lecturers and demonstrators. This is sometimes systematised into what, in a German University, would be called a "Seminar." The research course at the Chelsea Polytechnic, under the direction of Mr. Herbert Tomlinson, F.R.S., may be cited.

The subject selected for the first research is "The effect of repeated heating on the magnetic permeability and electrical conductivity of iron and steel." The investigations are being accompanied by demonstrations and lectures on (1) the best methods of annealing iron and steel and the faults incidental thereto; (2) the determination of magnetic permeability both by ballistic and magnetometric methods; (3) the determination of the electrical conductivity of magnetic metals; (4) the critical temperature of iron and its alloys.

The method of conducting the research is, too, worthy of mention. To begin with, the principal selects some suitable subject, and fully explains to the class his reasons for such selection. He then gives a brief history of what has been previously done round and about the subject, and propounds a mode or modes of attacking the research, inviting criticisms from the class. The mode of attack having been decided upon, the class is expected not only to take part in the experiments but to help in making necessary apparatus. Should the results obtained be of sufficient importance, they are to be offered in the form of a paper to such societies as the Royal Society, the Physical Society, or the Institution of Electrical Engineers.

Enough has been culled from Mr. Sidney Webb's paper to show that the London Polytechnic is a pure addition to the educational system, neither competing with nor superseding existing institutions. There are, among all the 50,000 members and students of these new establishments, probably not a dozen who would have been found joining University or King's College had the polytechnics never come into existence. There is, Mr. Webb says, every indication that the whole 50,000 are a net gain, and represent the arrival of a poorer class of students than the University Colleges have as yet reached.

Science in Girls' Schools.

Mrs. Bryant, headmistress of the North London Collegiate School for Girls, in a paper on "The curriculum of a girls' school," while admitting that the scientific interest arises almost as early in a child's mind as the literary and human interests, lays it down that the power to satisfy it develops much more slowly, so that the progress made is comparatively insignificant, even when the time spent is considerable and the methods sound. Nevertheless, it is recognised that the youngest children of school age are capable of elementary work in natural history. Such work at the beginning can hardly be called natural science, but it is of the nature of science if rightly carried out. An hour a week, increasing to two hours, may thus be profitably spent. At eleven or twelve children enter on physical science by very simple experimental investigations of the properties of matter. The ideal of the school curriculum in physical science is, it is suggested, a course of general elementary physics, starting with easy measurements and leading up to chemical problems, and eventually to chemistry. Mrs. Bryant thinks it is better for girls to carry on chemistry as a special study than to pursue any of the physical branches to the same extent. It has been found that backward pupils, and those who enter school late, get their best chance of science by the pursuit of botany and natural history as regular studies, with occasional courses on quasi-scientific subjects, like hygiene. All the pupils should, at some period of their course, deal with the application of science to life in some form, hence, short series of lessons, during one term, on hygiene and domestic economy, should be arranged. An interesting note by Miss Edith Aitkin, the science mistress in the school of which Mrs. Bryant is headmistress, gives in detail how the science teaching in the North London Collegiate School for Girls is carried out.

The Heuristic Method of Teaching.

The art of making children discover things for themselves is the meaning Prof. Armstrong applies to the expression Heuristic method of teaching, and he contributes a very suggestive article on this theme to the second volume of the reports. After what is best described as an autobiographical account of his gradually developed belief in this system, Prof. Armstrong sketches historically the work of the British Association Committee and the Incorporated Association of Head Masters in formulating a scientific and logical introduction to physical and chemical studies. In 1888 the British Association Committee reported at the Bath meeting, that the replies received to a letter addressed to the headmasters of schools in which chemistry was taught—"have put them in possession of the actual facts connected with the teaching of chemistry in schools, and have made it clear that something should be done in the direction of promoting a more uniform and satisfactory treatment of the subject. The Committee think that some suggestions might now be made as to the method of teaching chemistry which should be followed in schools. If this can be done, it will certainly confer a great benefit on both teachers and examiners, and will be likely to lead to a more emphatic recognition of the merits of the science as an instrument of elementary education."

Two years later the same Committee recorded that—"it cannot be too strongly insisted that elementary physical science should be taught from the first as a branch of mental education, and not mainly as useful knowledge. It is a subject which, when taught with this object in view, is capable of developing mental qualities that are not aroused, and indeed are frequently deadened, by the exhaustive study of languages, history, and mathematics. In order that the study of physical science may effect this mental education, it is necessary that it should be employed to illustrate the scientific method in investigating nature, by means of observation, experiment and reasoning with the aid of hypothesis; the learners should be put into the attitude of discoverers, and should themselves be made to perform many of the experiments."

In 1895 a committee, appointed by the Incorporated Association of Headmasters, prepared a detailed syllabus of instruction in elementary physics and chemistry on the lines sketched out by the British Association Committee, and this syllabus was adopted by the headmasters in 1896. This detailed schedule has had a marked effect, both upon the personal teaching in

secondary schools, and also upon the character of the text-books which have been published from time to time for use in such schools.

Not only have many headmasters been won over to this newer and more intelligent mode of imparting scientific instruction, but the various examining bodies—the local examination authorities at Oxford and Cambridge, as well as the Senate of the London University—are all moving in the same direction. Examinations in elementary experimental science are becoming more and more practical. It is yearly becoming less common for examiners to be satisfied with verbal descriptions of scientific experiments, the candidates must be able to perform the experiments themselves and also draw the proper inferences from them.

In addition to other reasons why the heuristic method of teaching should be adopted, Prof. Armstrong claims for it that it conduces to the formation of moral and intellectual character and purpose. Children are encouraged to be properly inquisitive and inquiring; to observe correctly; to be neat and careful in all their work; to be economical; to attend patiently to details; to reason with judgment; to be handy, and to develop many other equally valuable characteristics.

For instruction in science to be carried out according to heuristic methods, ample room must be provided, but there need be no very special arrangements made. Prof. Armstrong enumerates the comparatively few necessaries in the way of fittings; they are: unfixed benches of the kitchen-table type, fitted with gas; one or two long sinks made of wood—elongated washing tubs; one or two benches fixed against the wall of the room, with cupboards (having a tray which will slide in and out) fixed in the space underneath; single draught-closet; considerable amount of wall space converted into blackboard; and free wall space, having upright battens affixed at regular intervals for attaching shelves or hooks. Apparatus should be provided to meet requirements as they arise, and "every effort should be made to utilise ordinary articles—medicine and pickle bottles, jam pots, saucepans, &c.—and to construct apparatus in the workroom; for this latter purpose a carpenter's bench and tools, vice and files, a small lathe, an anvil, and even a small forge should, whenever possible, form part of the equipment. Infinite injury is done at the present day, invaluable opportunities of imparting training are lost, by providing everything ready made." Centimetre-foot-rules, drawing-boards, T and set-squares, and balances *must*, however, be supplied. But the greatest of these is the balance. Says Prof. Armstrong, "altogether indispensable and essential as the primary weapon of heuristic instruction is the balance. There is no question that in the future the test of efficiency in a school will be the extent to which suitable balances are provided and used." Or, again, "the balance is to be regarded as an instrument of moral culture, to be treated with utmost care and reverence."

Appended to the article are the full courses of instruction in elementary science adopted by the Incorporated Association of Headmasters, and a course in botany framed by Prof. Marshall Ward, and included in the programme of the Joint Scholarships' Board Examinations.

PRUSSIAN SECONDARY EDUCATION FOR BOYS.

It is interesting to read, in the article entitled "Problems in Prussian Secondary Education for Boys," which Mr. Sadler contributes to vol. iii., of the part von Humboldt took in developing an effective plan of educational administration in Prussia. Humboldt was appointed Director of Public Education in 1792, and during the succeeding seventeen years was actively engaged in supplying the urgent need which was then felt for improved education. He insisted, among other things, that no one should be allowed to undertake higher education, even in private schools, who did not hold a certificate of competency awarded by a State authority. In 1808, he began to remodel Prussian secondary education; and the work of the succeeding ten years is carefully reviewed in Mr. Sadler's article. The eleventh section of this exhaustive inquiry is of especial importance at this time. It is concerned with the manner in which the growing need for more knowledge in the various branches of professional and commercial life has been met in Prussia. As Mr. Sadler says, "a really good secondary education, up to sixteen or nineteen as the case may be, does for a man what he can rarely do for himself in later years. It drills his intelligence, while the powers are still supple, and it presses into his mind, while the memory is still retentive and undisturbed by outside cares, a well-set foundation of necessary knowledge. But all over Germany these advantages have been made more accessible to the children of families of small means than is the case in England." It has been, moreover, a fixed principle in Prussia for some time, that the different types of secondary school should be kept distinct. "In the application of science to industry there has been an ever-increasing demand for young men of ability, well-trained in studies which equip them for business callings, instead of tending to estrange their sympathies from commercial life." The Education Department of Prussia now definitely accepts the idea of non-classical training as a part of a national system of higher education. The curricula and programmes of work for higher schools in Prussia, which follow the general article, should prove of great value in guiding English headmasters. That section which deals with natural science shows that in the gymnasium, or fully classical school, two hours a week are given in each form to the study of science. The teachers are instructed that "special importance is to be attached, not so much to the amount of what is learnt, as to the thoroughness with which it is studied." The endeavour must be "above all to guide the pupils to think and observe for themselves." In the Realgymnasium, or school with Latin only, and the Oberrealschule, or modern school, the amount of time given to science is increased in the higher forms to five hours a week in the Realgymnasium, and six hours a week in the Oberrealschule. It would take too much space to give a detailed account of the subjects, and the parts of them, studied in the different forms; but a reference to pp. 303–6 will give the necessary information.

HIGHER COMMERCIAL EDUCATION.

Mr. Sadler also contributes to vol. iii. an elaborate account of higher commercial education at Antwerp, Leipzig, Paris and Havre. The Institut Supérieur de Commerce at Antwerp aims at being a university for the future merchant, and at the special training of those to whom the consular service of the country will ultimately be entrusted. It is a public institution, under the inspection of the State, and its professors are civil servants. The Belgian government pays three-quarters of its annual cost, and the municipality of Antwerp the rest. Foreign students are admitted, and it is found that the associations thus formed are indirectly helpful to the furtherance of Belgian trade. The staff of the Institute consists of fourteen professors and two assistants, in addition to the director. To candidates who are successful in the final examination the Institute awards diplomas of merit, but these diplomas are not lightly given and are highly valued by business men. The diploma also qualifies a student to obtain one of the travelling scholarships awarded by the Government in order to encourage commercial inquiry. The scholarships are worth from 200*l.* to 250*l.* a year, and may be regarded as travelling studentships for commercial research.

One of the causes of the commercial advance of the German empire is the intellectual efficiency of the secondary schools, and of the higher Technical Institutes. "The secondary school is organised as the foundation, the higher Technical Institute as the crown." German non-classical secondary education prepares a boy to excel in commercial life, but the German secondary school authorities rigidly abstain on principle from any attempt at premature specialisation in commercial subjects. The first German Higher School of Commerce was last year established in Leipzig. There is to be a close correlation between this Higher School of Commerce and the University of Leipzig. The Director of the Leipzig School defines its objects "to be the raising of the position of the trading classes in social estimation, and their equipment with the higher level of expert knowledge which the conditions of modern industry require." Commercial opinion in Germany is not, however, unanimous in favour of the establishment of schools of commerce. Thus, in the Annual Report for 1897 of the Hamburg Chamber of Commerce the following remarks occur:—

"The science of business is a science which must be learned by practical experience. It cannot be picked up on the benches of a class-room. It must be acquired in practical life. A young man trained in a school of commerce will enter on practical life with his head full of all manner of preconceptions."

Mr. Sadler does not say much about the French Higher Schools of Commerce, but directs attention to the volume, "Commercial Instruction organised by the Paris Chamber of Commerce," which was prepared by that Chamber for the Chicago World's Fair of 1893. On the general question of commercial education, the following remarks are worthy of note. "All persons of experience heartily reprobate the

thrusting of so-called 'commercial subjects' into the curriculum of secondary day-schools. To cram up little boys of fifteen with odds and ends of commercial law and generalisations of commercial geography is to waste precious time which might have been devoted to subjects not only more elevating in themselves but more digestible by youthful minds."

CONCLUSION.

The foregoing sketch of some of the questions dealt with in the volumes under consideration does not exhaust the references to scientific instruction and higher education contained in them. Scattered through the reports are short allusions to other considerations which accentuate the importance of a fuller recognition of the claims of science as an effective instrument in education; and it is a happy augury that official publications of this kind should recognise so completely the good results which follow upon according science an important place in the curricula of secondary schools.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE annual meeting of the Association of Technical Institutions will take place on Thursday next, January 12, when an address will be delivered by the president, Lord Spencer.

THE canvassing committee under the Birmingham University scheme state that the total sum promised up to the date of the public meeting in the Council House in July last (95,658*l.*), had already been increased to about 115,000*l.* Mr. Frank McClean, F.R.S., has contributed the sum of 2000*l.* to the fund. The Lord Mayor of Birmingham announces a donation of 1000*l.* from Alderman T. S. Fallows, J.P. The committee will hold their next meeting on January 25, after which a second list of subscriptions will be published.

A WINTER meeting for teachers opened at the College of Preceptors on Monday, and will continue in session until the end of next week. The meeting was inaugurated by an address by Sir Joshua Fitch, and the programme also includes lectures on educational subjects, visits to educational institutions, a conference on the training of modern language teachers, a conference on science teaching, and a conversazione at the Clothworkers' Hall. The lectures will deal with the training of teachers, the practice of education (including the teaching of geography and of the "life sciences"), psychology applied to education, physiology applied to education, school hygiene, the training of the speaking voice, and other subjects. The conference on science teaching will be held at the South-West London Polytechnic, Manresa Road, Chelsea, next Thursday and Friday, and will consider the methods of teaching elementary experimental science (physics, chemistry and mechanics) in schools. In connection with the conference there will be an exhibition of apparatus used in schools for practical science teaching.

THE annual meeting of the Geographical Association will be held at the College of Preceptors on Wednesday, January 11, when an address will be given by the President, Mr. Douglas W. Freshfield. The Association was founded in 1893 with the object of improving the teaching of geography in secondary schools, and every one acquainted with what usually passes for geography instruction in such schools will acknowledge that there is much room for improvement. Rational methods of teaching experimental sciences are now being introduced into many schools, and geography ought to be brought into line with the new movement, for, when properly taught, it has a distinct educational value. All methods of science teaching which bring into play the pupil's intelligence, instead of merely loading the memory with names and isolated facts, should be encouraged; and as the work of the Association consists in spreading knowledge of improved methods of teaching geography, it deserves support. Intending members should communicate with Mr. J. S. Masterman, 55 Campden House Road, London, W.

A *Times* correspondent at Bombay reports that, on Saturday last, Lord Curzon received a deputation from the provisional committee of the proposed Imperial University, or Research Institute, to be established in India for the purpose of post-graduate instruction in the higher scientific and technical branches of learning. The petition referred to Mr. J. N. Tata's offer of property, representing a capital of 30 lakhs, and producing an income of a lakh and a quarter rupees, on trust to found an Imperial Institute, which it was thought would supply, with the help of the Government, the Native States, and the general public, this existing need. The present scheme was to found a separate institution open to graduates of all existing Universities, and fully equipped. The provisional committee submitted a draft Bill which had been prepared for the approval of the Government of India, with a scheme of studies and an estimate of the probable initial expenditure. The initial expenditure was put at 15 lakhs, and the annual charge at 3 lakhs. The committee asked for the support of the Government of India, as the proposed University was intended for all India, and, being Imperial in character, deserved special consideration from the supreme Government. The committee further requested the Government to sanction a grant in aid towards the annual expenditure, remarking that the Secretary of State for India would favour such a grant. If the Indian Government proposed to extend a grant in aid to higher studies, the native Princes would cordially co-operate. Some of them had contributed to the Jubilee Health Institute, ths object being bacteriological research, which fell within the confines of the committee's draft scheme. They suggested the amalgamation of the resources promised by the native Princes to the Jubilee Health Institute with Mr. Tata's donations, and pointed out that considerable funds had been raised in the Punjab and Haidarabad for research purposes. Lord Curzon, in reply to the deputation, said that he had carefully examined their representations, and, though he could, of course, give no final answer, he could, at all events, assure them that the object which they had in view had enlisted his warm sympathy.

PRESIDENT CRAFT's annual report of the Massachusetts Institute of Technology shows that the past year was a remarkable one in the financial history of the Institute. More money was received through bequests and gifts than in any previous year. Under the will of the late Hon Henry L. Pierce, seven hundred and fifty thousand dollars were paid to the Institute by his executors. This is the largest sum ever given to it by any one benefactor. In addition to this, the executors of the late Mrs. Julia B. H. James have paid over the very notable sum of one hundred and forty thousand and five hundred dollars, this being also one of the largest gifts ever made to the Institute. Mr. George A. Gardner has generously given twenty thousand dollars as a fund, the income from which is to be used in the payment of salaries. Ten thousand dollars came from the late John W. Carter, and fourteen hundred and eighty-two dollars has been added to the large sum previously received from the estate of the late Mrs. Susan E. Dorr for the Rogers Physical Laboratory. Besides these gifts to the Institute itself, a Travelling Fellowship in the Architectural Department has been established by the will of Mr. Willard B. Perkins. For this purpose the sum of six thousand dollars has been given, the accumulated income from which is to be used every fourth year. Forty thousand dollars came from the estate of the late Mrs. Ann White Dickinson, the whole sum for scholarship purposes. A friend has given five hundred dollars to meet a special want, and two hundred dollars has come from Mrs. William B. Rogers, to be used for periodicals. It is expected that the Institute will receive four hundred thousand dollars from the estate of the late Mr. Edward Austin. This amount appears to be intended for scholarships and other similar uses, and will be highly appreciated; but the great desideratum for the immediate future is accessions to the unrestricted funds of the Institute.

The actual expense of instructing the students at the Massachusetts Institute is on the average three hundred and thirty dollars per year, while only two hundred dollars is paid as tuition fees. The balance, one hundred and thirty dollars, including interest on permanent investments, land, buildings, machinery, &c., has to be met from the past and present government and private benefactions. All through the reports from the different departments of the Institute notices are given of the introduction of advanced studies in consequence of advanced entrance requirements, and the school is making continued progress towards a higher standard for its degree. Another noteworthy feature is the progress towards a greater subdivision of students into small sections in laboratories, and the constantly increasing value placed upon laboratory work. During the past four years this movement has led to the appointment of eighteen new instructors, while the total number of students has remained about the

same. The number of students last year was 1171. If any one figure can be taken as a measure of the efficiency of a well-conducted school, it is the ratio of the total number of students to the number of instructors in actual service. In the case of the Institute of Technology, without counting lecturers, there is one instructor to every eight or nine students—one of the very highest ratios in the United States.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 8, 1898.—"Mathematical Contributions to the Theory of Evolution. VI. Reproductive or Genetic Selection. Part I. Theoretical." By Karl Pearson. "Part II. On the Inheritance of Fertility in Man." By Karl Pearson and Alice Lee. "Part III. On the Inheritance of Fecundity in Thoroughbred Race-horses." By Karl Pearson, with the assistance of Leslie Bramley-Moore.

The object of this memoir is twofold: first, to develop the theory of reproductive or genetic selection[1] on the assumption that fertility and fecundity may be heritable characters; and, secondly, to demonstrate from two concrete examples that fertility and fecundity actually are inherited.

The problem of whether fertility is or is not inherited, is one of very far reaching consequences. It stands on an entirely different footing to the question of inheritance of other characters. That any other organ or character is inherited, provided that inheritance is not stronger for one value of the organ or character than another, is perfectly consistent with the organic stability of a community of individuals. That fertility should be inherited is not consistent with the stability of such a community, unless there be a differential death-rate, more intense for the offspring of the more fertile, *i.e.* unless natural selection or other factor of evolution holds reproductive selection in check. The inheritance of fertility and the correlation of fertility with other characters are principles momentous in their results for our conceptions of evolution; they mark a continual tendency in a race to progress in a definite direction, unless equilibrium be maintained by any other equipollent factors, exhibited in the form of a differential death-rate on the most fertile. Such a differential death-rate probably exists in wild life, at any rate until the environment changes and the equilibrium between natural and reproductive selection is upset. How far it exists in civilised communities of mankind is another and more difficult problem, which I have partially dealt with elsewhere. At any rate it becomes necessary for the biologist either to affirm or deny the two principles stated above. If he affirms them, then he must look upon all races as tending to progress in definite directions—not necessarily one, but possibly several different directions, according to the characters with which fertility may be correlated—the moment natural selection is suspended; the organism carries in itself, in virtue of the laws of inheritance and the correlation of its characters, a tendency to progressive change. If, on the other hand, the biologist denies these principles, then he must be prepared to meet the weight of evidence in favour of the inheritance of fertility and fecundity contained in Parts II. and III. of the present memoir.

The theory discussed in Part I. opens with the proof that if fertility be a function of any physical characters which are themselves inherited according to the law of ancestral heredity, then it must itself be inherited according to that law. As fertility would certainly appear to be associated with physique, we have thus an *à priori* argument in favour of its inheritance.

Further points dealt with are the influence of "record-making" on apparent fertility and fecundity. The fertility of mothers is always found to be more and their variability less than the fertility and variability of daughters. Accordingly from the apparent fertility and variability of the record the actual values in each generation must be deduced.

Methods are developed for finding correlation coefficients from the means of "arrays." These methods are of considerable importance, for they enable us to ascertain the correlation between a latent character in one sex and a patent character in another, or between characters latent in two individuals. Thus, it is shown that the correlation between the brood-mare's fecundity latent in two related stallions can be deduced from the correlation between the mean fecundities of their two arrays of daughters. In this way a numerical estimate can be formed of the inheritance of latent characters.

The effect of a mixture of correlated and uncorrelated material on correlation and variation is next investigated, and it is shown that the former is more seriously affected than the latter. Incidently the problem of the mixture of heterogeneous materials uncorrelated in themselves is investigated, and it is shown that a correlation will result in the mixture. This *spurious* correlation is of some importance for the question of mixtures of classes in fertility problems, but it is also significant of the general danger of heterogeneity in bio-statistical investigations, and further indicative of the possibility of creating correlation between two characters by breeding between small heterogeneous groups in which this correlation is zero.

Part II. of the memoir deals with the inheritance of fertility in man. It is first shown by large numbers that fertility is undoubtedly inherited from mother to daughter, but that if we include all types of marriages the inheritance is largely screened by other factors. An attempt is made to remove one by one these factors, and the more stringently this is done the more nearly the regression of daughter on mother moves up towards he value required by the law of ancestral heredity.

The inheritance of fertility from father to son is then considered; this is really rather an inheritance of sterility or tendency to sterility, for the full fecundity of a man is not usually exhibited in monogamic union. It is rather a problem of whether his fecundity lasts as long as his wife's. We find definite inheritance from father to son of this sterile tendency, although for the reason just given it falls below that indicated by the law of ancestral heredity.

Lastly, the inheritance of fertility in the woman through the male line is dealt with, and it is shown that a woman's fertility is as highly correlated with that of her paternal as with that of her maternal grandmother. In other words the latent character, fertility in the woman, is transmitted through the male line, and with an intensity which approximates to that required by the law of ancestral heredity.

Part III. of the memoir contains the results of a somewhat laborious investigation into the fecundity of brood-mares, which has been a number of years in progress.

(1) Fecundity in the brood-mare is inherited from dam to mare.

(2) It is also inherited from grand-dam to mare through the dam.

In both these cases the intensity is much less than would be indicated by the law of ancestral heredity, but the divergence is not such that it could not be accounted for by a percentage of fictitious values such as the peculiar conditions of horse-breeding warrant us in considering probable.

(3) The latent quality, fecundity in the brood-mare, is inherited through the sire; this is shown not only by the correlation between half-sisters, but by actual determination of the correlation between the latent character in the sire and the patent character in the daughter.

(4) The latent quality, fecundity in the brood-mare, is inherited by the stallion from his sire. This is shown not only by the fecundity correlation between a sire's daughters and his half-sisters, but also by a direct determination of the correlation between the latent quality in the stallion and in his sire.

In both these cases of latent qualities the law of inheritance approaches much more closely to that required by the Galtonian rule.

Parts II. and III. accordingly force us to the conclusion that fertility is inherited in man and fecundity in the horse, and therefore probably that both these characters are inherited in all types of life. It would indeed be difficult to explain by evolution the great variety of values these characters take in allied species, if this were not true. That they are inherited according to the Galtonian rule seems to us very probable, but not demonstrated to certainty. It is a reasonable hypothesis until more data are forthcoming.

PARIS.

Academy of Sciences, December 26, 1898.—M. Wolf in the chair.—Some peculiarities of the elasticity of muscle explained by comparison of the case of muscular substance in action with that of inert materials, by M. A. Chauveau. An experimental

[1] I have retained the term "reproductive" selection here, although objection has been raised to it, because it has been used in the earlier memoirs of this series. Mr. Galton has kindly provided me with "genetic" and "proliferal" selection. The term is used to describe selection of predominant types owing to the different grades of reproductivity being inherited, and without the influence of a differential death-rate.

comparison of the elasticity of vulcanised india-rubber with that of muscle in a state of physiological work. The results are expressed graphically in a series of six diagrams.—Histology of the skin: the epidermal fat of birds, by M. L. Ranvier. A study of the cause of the difference between the epidermal wax of mammals and the fatty material obtained from the feet of birds. A tangential section from the scaly portion of a chicken's foot, stained with osmic acid, showed that the epidermal cells are charged with liquid oily drops.—On a photograph of the nebula of Baleine obtained at the Observatory of Toulouse, by MM. Bailland and Bourget. The spiral in the nucleus, first described by Lord Rosse, is very clearly marked in the photograph.—Observations and elements of the new Chase comet, by M. G. Fayet.—On differential systems the integration of which can be reduced to that of total differential equations, by M. Riquier.—On differential equations of the first order, by M. Armand Cahen.—On linear total differential equations, by M. Alf. Guldberg.—On the velocity of sound in dry air at 0° C., by M. A. Leduc. A reply to the criticisms of M. Violle.—Influence of pressure on the initial polarisation capacity, by M. A. Chassy. Polarisation cells containing electrodes of various metals, as well as platinum black, were submitted to pressures ranging from 1 to 2000 atmospheres, without any appreciable change in the value of the polarisation capacity being noticeable. It is hence concluded that the phenomenon of initial polarisation does not correspond to an electrolytic decomposition into gaseous elements.—Radioconductors, with gold and platinum filings, by M. Édouard Branly. The use of gold powder for the preparation of tubes used in the detection of Hertzian waves has been negatived by Prof. Oliver Lodge; but the author finds, on the contrary, that although the successful use of tubes of this metal requires more delicate handling than other powders, this objection is more than counterbalanced by the extreme sensitiveness of the apparatus.—On a solution of the problem of multicommunication in telegraphy by the use of electric oscillations, by M. Albert Turpain. Having given several stations, A, B, C, . . . L, N, distributed along a single wire A N, the arrangement described permits of the simultaneous telegraphic or telephonic transmission of message between any pair of stations.—Remarks on the simple kathode rays, by M. H. Deslandres. A discussion of the views of M. Goldstein, and of his claims to priority on this subject.—On a new strongly radio-active substance contained in pitchblende, by M. and Mme. P. Curie and M. G. Bémon (see p. 232).—On the spectrum of a new radio-active substance, by M. Eug. Demarcay.—Researches on the separation and estimation of the halogen elements in their combinations with silver, by M. H. Baubigny. The mixed halogen silver salts are treated in the moist state with sulphuric acid and potassium bichromate at 90°–95° C. Under these conditions the iodide is quantitatively converted into iodate, and the chlorine and bromine set free. The test analyses are very satisfactory.—Action of oxidising agents upon some fatty and aromatic amines, by MM. Œchsner de Coninck and A. Combe. In presence of energetic oxidising agents the fatty amines are gradually decomposed, giving CO_2 and N_2. Under the same conditions the aromatic amines give colouring matters which are slowly decomposed with evolution of CO_2.—Thermal study of normal propylmalonic acid. Heat of formation of the solid potassium salt, by M. G. Massol.—On the oxidation products of oxygluconic acid, by M. Léon Boutroux. Oxidation with nitric acid gave racemic, trioxyglutaric, glyoxylic, and dioxybutyric acids.—The anti-virulent power of the serum of man and animals immunised against vaccinal or variolic infection, by MM. Béclere, Chambon, Menard, and Jousset.—On an example of *Dasypeltis scabra*, by M. Léon Vaillant. Fall of fossilised crustacean ostracods observed at Oullins, near Lyons, September 24, by M. Lortet.—Contribution to the study of the morphology of the Craspedomonadeæ, by M. J. Kunstler. On the presence of *Pinus sylvestris* in the quaternan gravels near Troyes, by M. P. Fliche. The remains found consist of the wood, roots, branches, bark, and cones, the latter being especially well preserved. The fossils do not occur in the base of the gravel, but are very abundant in the middle region.—On the discovery of graptoliths in the conglomerates of the vosgian grit in the neighbourhood of Raon-l'Étape, by M. Bleicher.—Appearance of the bear in the Miocene period, by M. Claude Gaillard.—On the folding of strata near Belledone, by M. P. Lory.—On the foldings of the Cretaceous strata of the Aquitaine basin, by M. Ph. Glangeaud.—On the origin of the iron ore of the Neocomian at Bray, by the superficial alteration of iron carbonate, and on the importance and continuity in depth of the carbonated ore, by M. W. de Mercey.—Observations by M. de Lapparent on the preceding paper. On the existence near Corinth of lherzolites identical with those found in the Pyrenees, by M. A. Lacroix.—On a new law relating to the grouping of crystals, by M. Fr. Wallerant.—New researches on a means of preventing oak wood from being worm-eaten, by M. Émile Mer.

DIARY OF SOCIETIES.

TUESDAY, JANUARY 10.

INSTITUTION OF CIVIL ENGINEERS, at 8.—High-Speed Engines: John Handsley Dales.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—On Micronesian Weapons, Dress, Implements, &c.: F. W. Christian.

WEDNESDAY, JANUARY 11.

SOCIETY OF ARTS, at 7.—Juvenile Lecture: Some Ways in which Animals Breathe: Prof. F. Jeffrey Bell.

THURSDAY, JANUARY 12.

MATHEMATICAL SOCIETY, at 8.—On a Determinant each of whose Elements is the prduct of k Factors: Prof. W. H. Metzler.—Properties of Hyper-space, in relation to Systems of Forces, the Kinematics of Rigid Bodies, and Clifford's Parallels: A. N. Whitehead.—A Simple Method of Factorising Large Composite Numbers of any unknown form: D. Biddle.—Zeroes of the Bessel Functions (second paper): H. M. Macdonald.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

BOOKS and SERIALS RECEIVED.

BOOKS.—Catalogue of the Lepidoptera Phalænæ in the British Museum: Sir G. F. Hampson (London).—Plates to ditto.—The Brain Machine: Dr. A. Wilson (Churchill).—Les Terres Rares: P. Truchot (Paris, Carré).—Advanced Inorganic Chemistry: Dr. G. H. Bailey (Clive).—The Principles of Stratigraphical Geology: J. E. Marr (Cambridge University Press).—Octonions: Prof. A. McAulay (Cambridge University Press).—Scientific Papers of Prof. P. G. Tait, Vol. i. (Cambridge University Press).—Spherical Trigonometry: W. W. Lane (Macmillan).—Introduction to the Theory of Analytic Functions; Profs. Harkness and Morley (Macmillan).

SERIALS.—Longman's Magazine, January (Longmans).—Agricultural Gazette of New South Wales, October (Sydney).—National Review, January (Arnold).—Bulletin of the American Mathematical Society, December (N.Y., Macmillan).—Physical Review, September-October (Macmillan).—Humanitarian, January (Duckworth).—Contemporary Review, January (Isbister).—Journal of the Royal Horticultural Society, January (117 Victoria Street).—Journal of the Royal Microscopical Society, December (Williams).—Journal of Experimental Medicine, Vol. 3, No. 6 (Appleton).—American Naturalist, December (Ginn).—Brain, Part 83 (Macmillan).

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THURSDAY, JANUARY 12, 1899.

THE DEVELOPMENT OF RESEARCH.

The Discharge of Electricity through Gases. By Prof. J. J. Thomson, D.Sc., F.R.S. Pp. 203. (Westminster: Archibald Constable and Co., 1898.)

THIS work is an expansion of a series of lectures delivered at the University of Princeton, New Jersey, U.S.A., in October 1896. This practice of the American universities of inviting distinguished authorities to deliver courses of lectures is an admirable one. Lord Kelvin's Baltimore lectures were delivered under similar auspices, and it is to be hoped that the promised publication of these most interesting lectures will soon take place. By thus bringing our greatest living authorities into personal relations with the staff and students of a university an energetic stimulus is given to their studies and investigations. It might be said that the local staff and students can, if they wish, read the works of any authorities they desire to study. This is no doubt true, and it makes it now possible for each university by producing new knowledge to teach all the world, and not only those who come to reside in its vicinity. Thus the real students of each university are now spread all over the world and not confined to its precincts, as they were before the reproduction and distribution of thought was as easy a matter as it is to-day. And this is a great and important duty for universities, this producing and teaching new knowledge to mankind, but it is not their only duty. They should produce investigators and discoverers as well as investigations and discoveries. Under existing conditions, investigations and discoveries in the borderlands of science cannot reasonably be expected to lead to immediately useful results to mankind. They may be most useful to our grandchildren, but one cannot reasonably expect the ordinary motives of self-interest, to which the greater part of the good work of the world is due, to produce great work which may be of use to other people's grandchildren. For the production of such work, society, which has the greatest interest in the matter, must depend upon other motives for the production of great discoveries in pure science. The motives and abilities that must here be depended on do not exist in at all the same proportion of mankind as self-interest and that general ability to carry out rules which is sufficient for so much of the world's work. Enthusiastic devotion to the investigation and discovery of what is true, and the intellectual acuteness required for its successful pursuit, are not of common occurrence, and in a great many cases without special encouragement and training will, even in those who are capable of having these capacities highly developed, be overpowered by the distractions of other motives claiming attention to other fields of work. It is an important duty for universities to seek out those in whom it is possible to develop these motives and abilities; to encourage them to cultivate these abilities, and to strengthen in every way the hold of these motives on them. Almost the only way in which such motives can be strengthened is by the sympathetic encouragement of those who are already enthusiastic investigators and discoverers. That this is a really successful way of producing the character desired is fully proved by the existence of *disciples* in every branch of human endeavour that involves enthusiastic devotion of life. How is it that so many of the passing generation of chemical discoverers have been workers in the laboratories of Liebig, for example? The proportion of chemists who studied with Liebig to the whole body of those who have studied chemistry is very small indeed, but the proportion of leaders of chemical discovery who have studied under Liebig to the whole number of leaders of chemical discovery is quite large. Why? Because Liebig's example was catching, his personality was inspiring, his enthusiasm begot enthusiasm in his pupils; they became more than pupils, they became disciples.

It is in pursuit of this end that the American universities desire to bring their staff and students into personal relations with the leaders of thought. Though there is every prospect that they soon will be, they are not yet rich enough to control the market of English-speaking thought production by making permanent appointments, but they can and do provide for a temporary residence of a leader of thought amongst them. They do what they can to bring themselves into personal relations with those who are likely to stir their enthusiasm for research into useless truth, and thus strengthen the motive which distinguishes investigators and discoverers of the kind universities should produce.

These lectures are eminently inspiring. They are full of the seed from which discovery springs, of those sign-posts on the borderlands of the known which point out directions in which further knowledge is required. They call attention to important investigations now in progress, to the results so far achieved and to the results, too, that are still only probable and require further investigation. We do not generally get this in a book. We may find it in published papers, but we should find it in lectures delivered for the purpose of directing and encouraging the researches of others. So much of this is of only ephemeral value, though, like our dinners, of enormous importance for each day's work, that it is not usually published in book form nor often in scientific papers, notwithstanding such an illustrious example as Faraday. Working hypotheses, suggestions for work, all these may turn out wrong, or useless for further advance, but may be a very necessary part of the means of advancing. We eat much that we cannot assimilate in our dinners: it is a necessary concomitant of our food, and a reasonable quantity of it is possibly necessary for the satisfactory working of our organisms. Be that as it may, the question of real importance in working hypotheses is not so much, were they true, as, did they lead to advance towards truth. Very few, indeed, who have not suggested many wrong working hypotheses have advanced truth at all, and still fewer have had enthusiastic disciples.

In these lectures we have studies of the possible causes of atmospheric electricity depending on electro-superficial double layers, a subject deserving most careful investigation; studies of a remarkable penetration of kathode ray actions through such thick conductors that Lenard rays seem out of the question, and that raises the important question of the continuity or otherwise of the

discharge in gases; studies of the mysterious photo-electric effects at the surface of bodies and throughout the body of a gas, and that cloud-producing action which seems to provide us with the opportunity of isolating electrons, obtaining a drop of liquid with only one of these upon it; studies of kathode rays and of the velocity of the electric carriers in them. The argument by which, in this concluding study, there is an attempt to prove that these cannot be either larger than molecules, nor of a comparable size, is not particularly conclusive. Among the reasons given for concluding that these carriers are not larger, it is assumed that the resistance to their motion would obey the laws of motion of a body moving slowly through a viscous medium. This is not at all true of a minute projectile moving with a velocity of at least one hundred times the velocity of the molecules of the gas. To such a projectile the gaseous molecules would be practically at rest, and the resistance would be, as Lenard observed, proportional to the density of the gas. The argument against their being of a size about the same as that of the other gaseous molecules depends on the assumption that the effective size of a molecule is independent of its rate of motion, a conclusion which is at variance with the known laws of diffusion of gases at various temperatures, and is contrary to such a probable hypothesis as that the actions between molecules is more like that between centres of force with rapidly changing forces near them than like that between hard spheres. For a comet to be deflected by a given amount when going near the sun, it should pass much closer to the sun if its velocity is large than if its velocity is small. The effective size of the sun as a deflecting cause for comets very largely depends on the velocity of the comet. On these principles rapidly moving molecules might go much further through a gas than the free path of an ordinary molecule. When the disagreement between the theory of hard spheres and the observed laws of diffusion at different temperatures is measurable, and it only corresponds to alterations of velocity to about twice the normal, we may naturally expect great variations when dealing with velocities of about one hundred times the normal, which would correspond to a temperature of some 2,000,000° C.

At the same time, there is a good deal of other evidence in favour of the suggestion that in kathode rays we are dealing with carriers of smaller mass than atoms. One would naturally conclude that we were here dealing with what might be described as disembodied electrons, *i.e.* with electrons separated from the atoms with which they seem in general so intimately connected. Most theories of electrolysis assume that an electron can be transferred from the atom in the liquid to the plate, and almost any theory of metallic conduction must involve the transference of electricity from molecule to molecule in the conducting solid. The only difference between these cases and that of the supposition that kathode rays are torrents of electrons is as to the distance the electron can travel from molecule to molecule. If it can ever leave one molecule to join on to another, why may it not jump some centimetres of space between them? This reconciles to some extent the radiant matter and pure ether theories of the kathode rays. It makes them essentially an ether phenomenon, while at the same time they are streams of particles: it makes them light on the emission theory.

It ought to be possible to test whether these emissions are material or not, by collecting them in a small vacuum tube. It is not generally appreciated how very small a mass of gas there is in a small highly exhausted vacuum tube, though it contains enormous numbers of molecules. At the pressure of a millionth of an atmosphere, which is quite a large pressure of about a dyne per sq. cm., there could be collected in a few minutes in a tube of several cubic millimetres capacity a quantity of hydrogen which it would require 100,000 years collecting at the same rate in order to collect a gramme of it.

In every way the book is suggestive, interesting, and inspiriting, and as such should fulfil its purpose of provoking research and advancing science.

GEOMETRY OF POSITION.

Lectures on the Geometry of Position. By Theodor Reye, Professor of Mathematics in the University of Strasburg. Translated and edited by Thomas F. Holgate, M.A., Ph.D., Professor of Applied Mathematics in North-western University. Part I. Pp. xix + 248. (London: Macmillan and Co., Ltd. New York: The Macmillan Company, 1898.)

AT last there is an English edition, translated in America, of the first part of Prof. Reye's "Geometrie der Lage," of which the first edition appeared as long ago as 1866. The methods followed offer so many advantages, and the style adopted is so lucid, that we heartily welcome this translation, and we with confidence express the hope that it will awaken new interest in the study of this charming subject in this country as well as in America.

The book owes its origin to lectures delivered to engineering students at the Polytechnic School at Zürich. They were undertaken with the view of giving the students that geometrical knowledge which they required in order to listen with advantage to Culmann's lectures on graphical statics.

Culmann based his new science upon the very abstract "Geometrie der Lage" by Von Standt, and this prescribed the course which Reye had to follow. He did so willingly, and says in the preface to the first edition:—

"One principal object of geometrical study appears to me to be the exercise and the development of the power of imagination in the student, and I believe that this object is best attained in the way in which Von Standt proceeds."

The object of Reye's lectures, therefore, is not only to impart knowledge of conics and quadric surfaces, &c., but also and especially to educate the student's mind in the faculty of easily and readily realising geometrical figures in space, a faculty very important to engineers.

"Geometry of position," as opposed to "metric geometry," with which alone Euclid deals, excludes all measurement. But whilst the older authors and founders of this modern science based it on Euclidian propositions, Von Standt has shown that these can be altogether avoided, and Reye follows this course rigidly.

Here everything is based upon harmonic points in a range, and harmonic rays in a pencil, or, as the translator calls it, a sheaf.

All the previous knowledge needed consists of a clear notion of the concepts of point, line and plane, and their fundamental properties, such as the propositions that two points determine a line, two planes meet in a line, &c., together with a power of imagining these elements in their mutual relation in space; for instance, that a line may lie in a plane, or else can cut it in one point only.

These ideas being in the mind of the reader, nothing more is required, and they will themselves gradually become developed and gain in clearness as he proceeds.

It goes without saying that such a system requires a number of new concepts; namely, those of the primitive forms, "the elementary prime forms" in Leudesdorf's translation of Cremona's "Projective Geometry." These are explained in Lecture i.

In the second lecture the correlations between the prime forms as given by projections and sections are considered, and these lead to the ideal elements at an infinite distance. By their aid the exceptions due to parallelism are got rid of. At the same time a first instance is given of the leading principle of "correspondence" between the elements in two or more prime-forms.

In Lecture iii. the principle of duality appears as a natural and simple consequence of the first and fundamental properties of the elements.

After these preliminary lectures we come in the next to "harmonic forms," which are deduced by aid of certain simple constructions in three dimensions without reference to measurement. There is added a discussion of their metrical properties.

In the fifth lecture we have the projective properties of primitive forms, and the all-important principle of correspondence between the elements in two of them. It ends with the generation of curves of second order and second class, respectively, by projective ranges and sheaves (flat pencils), the actual construction of points on, or tangents to such curves being given.

With this the reader has finished the preliminary work. It may at first have appeared to him somewhat tedious, as he is unable to appreciate the usefulness and fertility of the definitions and methods explained. He has acquired many definitions and plenty of new ideas, but not as in Euclid at every step a tangible result. This is now all changed. The next chapter shows that the time and trouble expended are to be amply repaid, for now the study of the curves mentioned begins, and he is told that these curves are the conic sections. Side by side with these go the generation and the properties of cones of the second order, and cones of the second class, but these are at once dropped, as their properties are an immediate consequence of the curves. The latter are now investigated in detail. Their construction is more closely examined, and leads almost at once to the celebrated theorems of Pascal and Brianchon. It also follows that five points or tangents determine a curve of the second order or class.

The fact that these fundamental properties appear at the very beginning is characteristic of the whole method, and this shows that the method is a natural one.

In the seventh chapter the more immediate consequences of these theorems is considered. The curves are also classified as ellipses, hyperbolæ, and parabolæ, according to their elements at infinity.

In Chapter viii. the special case of Pascal's theorem when the hexagon is reduced to a quadrilateral leads to the theory of pole and polar, and these are in the next lecture specialised by aid of the lines and the points at infinity so as to give the properties of centres, diameters, and axes of conics. In this lecture, too, the equations of the conics are obtained, and thus the proof is given that the conics studied by aid of coordinate geometry are the same as those here considered.

Of course the principle of duality is constantly used, and properties of curves of second order and second class are treated simultaneously till in Lecture vii. their identity is proved. Numerous other theorems of conics are given at every stage, but we have only mentioned a few in order to show the sequence in which they follow.

Of this enough has been done, and the contents of the rest of the book can be dealt with more summarily.

Lecture x. treats of the ruled quadric surfaces; the next of projective relations of "elementary forms," viz. the range, the sheaves, curves and cones of second order, and the ruled quadric surfaces.

These relations lead to the "theory of involution," Lecture xii. The metric properties are considered in Lecture xiii., and applied to establish the *focal properties* of conics; whilst in Lecture xiv. problems of the second order are solved, and "imaginary elements" introduced in the manner of Von Standt. By their aid problems are solved by actual construction on the drawing board, in which among the given data are "imaginary" elements; for instance, the problem of drawing a conic which passes through three given points, and the two points in which a given line cuts a given conic in the case where these points have no actual existence.

It will be seen that hereby again the greatest generality is obtained, and that the exceptions which would occur if the different case where the line cuts the conic, touches it, or does not cut it, are to be treated separately.

In the fifteenth and last lecture, principal axes and planes of symmetry, focal axes, and cyclic planes of cones of the second order are dealt with.

This finishes the first part of Reye's work, which is restricted to the investigation of curves and surfaces generated by projective primitive forms of one dimension, the range of points, the sheaf of lines and the sheaf of planes, that is the range and the flat and axial pencil.

The projective and primitive forms of two dimensions give rise to quadric and cubic surfaces and twisted cubic curves, whilst the forms of three dimensions, viz. the space with points and planes as elements lead to the theory of co-linear and reciprocal spaces. These form the contents of Vol. ii. The translator does not say anything about it, but as the volume before us is marked both on the title-page and the back as Part i., there seems reason to hope that the translation of the second part will soon follow.

There is, however, an appendix to Part i., which has still to be mentioned. It contains an account of the principle of reciprocal radii, Dupin's cyclide, ruled surfaces of the third order, quadrangles and quadrilaterals, which are self-polar with respect to conic sections, and lastly a pretty full, though condensed, account of nets and webs of conic sections.

The translation is very well done. It has evidently

been a labour of love to Prof. Holgate. He has, however, in the terminology departed somewhat from that which has been used in this country. He has altogether eschewed the word "pencil"; instead of it he uses for the flat and axial pencils "sheaf of rays" and "sheaf of planes," thus appropriating the word sheaf to one-dimensional forms, whilst it has in England been used for pencils of lines and planes in space. For these he takes the word "bundle," thus adopting the German phraseology. We think it is a pity he has made this change, not because the old terminology is better, but because it makes the adoption of a uniform system more difficult.

The translator has made a few changes from the original. He has broken up the lectures into articles which he has numbered, and he has placed the numerous exercises at the end of each lecture to which they belong, instead of leaving them together at the end of the book as in the original. He has also added an index. These are decided improvements. In his preface he gives a short account of the history of projective geometry.

As far as the paper, the printing and the figures are concerned, the book ranks among the best we have seen; in these respects it is, in fact, above praise.

We recommend the book to *all* students of mathematics, and advise them not only to read it, but also to actually make accurate drawings of at least a great number of figures; especially to construct a variety of conics from given conditions, and to solve as many as possible of the problems proposed. These constructions should be made accurately on the drawing board. They offer a wonderful incitement to accuracy and neatness, as every fault in drawing becomes at once evident to the eye. For this reason the schoolmaster who has to teach mathematics and geometrical drawing on the modern or science sides of schools, will find it of great advantage in his teaching. The book will afford him innumerable examples for geometrical drawing, even if he cannot much hope to enter at present on teaching the theory: although there is no reason, as far as the difficulty of the subject is concerned, why he should not introduce a good deal in the higher forms. It is most stimulating to young students, as is evidenced by the fact that students have repeatedly told us that, although at school they could not take any real interest in Euclid, and found geometry very hard, they found the theory of conics as treated according to Reye delightfully easy and interesting. In fact, the subject is full of life; the figures grow organically one out of the other, and the Propositions arrange themselves in a natural sequence. O. HENRICI.

RACIAL ANATOMY.

Observations sur les Variations Musculaires dans les Races Humaines. Par Théophile Chudzinski. Memoires de la Société d'Anthropologie de Paris, Ser. 3; t. ii.; fasc. 2. (Paris, 1898.)

THIS posthumous work of Chudzinski is a laborious and systematic attempt to open up quite a new field of anthropological investigation. It may be said, with perfect truth, that the study of the various races of mankind has been superficial and empirical; observations hitherto have been confined to features, colour of skin, size of body, proportion of limbs and bone measurements. With the exception of the late Prof. Giacomini of Turin, Chudzinski is practically the only man that ever went beneath the skin to discover the real and essential features that separate one race of man from another. There is no desire here to minimise the value of the few briefly recorded dissections, made on dark-skinned waifs that have died in Europe, and found scattered in the anatomical literature of the present century; the observations on the brains of negroid races by Parker, Broca, Gratiolet, Waldeyer, Marshall, Tiedemann, Calori and Barkow are good so far as they go, dissections of individual specimens made by Flower and Murie, Cuvier and Turner, are efforts in a right direction, but the merit of having opened up a systematic investigation of the anatomy of the races of mankind, taking a group of individuals to represent the race, remains to Chudzinski and Giacomini. This treatise is a record of the muscles of ten negroes, five negresses, five individuals belonging to yellow-skinned races, contrasted with the muscles of six individuals of a white-skinned race.

The result of this laborious investigation is to show that, on an average, in size, in proportion of flesh and tendon, in relative and absolute extent of attachments, the muscles of Chinamen, Frenchmen and negroes are very different. Unfortunately, Chudzinski's methods are open to serious criticism. Take his account of the *soleus* muscle as an example; it is a muscle peculiarly adapted in men for erect progression. He gives in millimetres the extent of its attachment to the fibula: the extent of origin in white men is 135 m.m.: in yellow races, 97 m.m.; in negresses, 94·5 m.m.; in negroes, 120 m.m.: the extent of origin is greatest in white men, as one would expect, but it is obvious that a great error is introduced if no account is taken of the size and stature of the individuals compared, and of this factor Chudzinski has taken no cognisance. Only here and there are relative measurements given. Yet on the whole there can be no doubt that Chudzinski has, in his minute analysis of the muscular system, discovered very numerous features wherein the white, the yellow and the black man differ, and his results may be summarised by saying that, on the whole, the muscular arrangement in the white man is more accurately and powerfully adapted for erect progression of the body and precision in the use of his hands than in the negro, and in some points, although by no means in all, the muscular system is rather more simian in the negro than in the white man.

But by far the most valuable part of Chudzinski's work lies in his observations of muscular anomalies. Adding his work to Giacomini's it may be said, without any danger of over-stating the case, that the negro shows in his muscular anomalies twice or three times the number of simian characters met with amongst white men. Looking at it from the point of view of descent, the negro has retained certain primitive features much more than the white races, among them his black colour.

Little notice was taken in this country of Chudzinski's death, which took place in Paris some eighteen months ago. He was born a Pole, and, when a student at Moscow University, became involved in the insurrection of 1863, and, like many of his countrymen who afterwards became known in science, sought refuge in Paris.

He became laboratory assistant to Broca, and afterwards one of his ablest disciples. He was always extremely rich in modesty and poor in means; spent his life unostentatiously and contentedly plodding through a wilderness of dry detail to gather a handful of generalisations such as may be seen in this his last work.

OUR BOOK SHELF.

An Experimental Course of Chemistry for Agricultural Students. By T. S. Dymond. Pp. 192. (London: Edward Arnold.)

THE attempt is often made to teach agricultural science to students who have received no previous scientific training; the results of such an attempt are usually very unsatisfactory. Agricultural problems are indeed highly complex, and if the student is to understand the investigations which have been made to solve them, and is rightly to appreciate the results, he must be first acquainted with the laws and facts of nature which are involved in the phenomena under consideration. The teaching of pure science must thus always precede the teaching of applied science. Technical instruction given alone, can only consist of a series of directions and prescriptions, which are necessarily of very limited value. As soon as a scientific exposition of the subject is attempted, the preliminary study of pure science becomes essential to success.

The book before us is an introduction to chemical science, intended for students who are about to study the chemistry of agriculture. The course of instruction is intended to be given in a chemical laboratory, and the greater part of the experiments are to be performed by the students themselves; this is undoubtedly the best way of learning a science. Mr. Dymond is much to be congratulated on the very carefully constructed scheme of work which he has now published; its practical merits are doubtless to a considerable degree due to the fact, mentioned in the preface, that the scheme has been in use during the past three years in many evening schools and classes in the County of Essex; the ideas of the author have thus been gradually perfected by practice. The course is intended as an introduction both to inorganic and organic chemistry. The subjects selected for the various lessons are, when possible, of an agricultural character. Too much is sometimes attempted in this direction. Subjects such as the physical properties of soil, and the composition and properties of milk and butter, fully deserve to be treated of in several lessons, instead of the present brief notes in small type. The two pages on the chemistry of animal and vegetable life are a further example of the inadequate treatment of subjects which really lie outside the scope of the present course. Mr. Dymond would do well to write a second course of instruction, to follow that which he has now published; in this the problems of agriculture could be made the principal subjects of study. We can cordially commend the book. R. W.

Gesammelte Botanische Mittheilungen. Von S. Schwendener. Two volumes. Pp. iv + 453 and 419. (Berlin: Gebrüder Borntraeger, 1898.)

THE last few years have seen the appearance of "collected works" of more than one eminent German botanist, and all students in the science will welcome the newest addition to this form of literature.

Truth to tell, Prof. Schwendener's work has hardly met with the general recognition it deserves. Of course every one is familiar with his relation to the lichen controversy, and most of us have doubtless a more or less intimate knowledge of his work on the ascent of sap. Of his other writings, especially on physical matters many have but a very scant acquaintance, and even the anatomical papers are not as widely read as they deserve.

In a great measure this is no doubt due to the medium which Dr. Schwendener commonly selected for publication, which prevented their free circulation amongst fellow students; but now they are rendered accessible, they will assuredly command more attention at first hand. For there is an immense amount of valuable and interesting matter contained in the bulky volumes before us, even though it is not always possible to follow the author's meaning with ease, owing to his somewhat difficult style.

The papers are all accurate reprints (with the plates) of the author's works which have been published since 1879; but where his views have undergone modification since the appearance of any paper, readers will find his present opinions stated in the appendices which are added at the end of the text.

As the papers have thus appeared for some time, it is not necessary to discuss their contents here; and it may suffice to say that they deserve, and doubtless will obtain, an honoured place in every botanical library.

Die Bewegung im Weltraum. Von E. Kethwisch. Pp. 184. (Berlin: Schneider, 1896.)

THIS book contains a criticism of the theory of universal gravitation, although it does not deny that Newton explained the harmony of the universe with mathematical exactness. A statement of a few of the conclusions at which the author arrives, will probably suffice for the readers of NATURE.

According to the theory of gravitation the sun maintains the planets in their orbits; but what is the force that prevents the sun moving off into space? The theory demands some larger body which shall hold the sun, this new body demands another, and so *ad infinitum.* The theory of gravitation is thus reduced to an absurdity.

On p. 23 we learn that the number of oscillations of a pendulum is quite independent of the force of gravity. In fact, that theory demands that a heavy body shall attract another with greater force the lighter is the latter.

The attraction of Schehallien, as observed by Maskelyne, was due to magnetism; and if Cavendish had made his celebrated experiment with non-magnetic bodies, he would not have detected any attraction.

The discovery of Neptune affords no proof of the theory of gravitation. The received theory of the tide is absurd, as lunar attraction cannot possibly cause the semi-diurnal tide. The force of gravity on any planet is wholly due to its rotation, and its intensity is directly proportional to the *linear* velocity of a point on the equator.

It is probable that this work contains many other remarkable propositions; but the writer of this notice did not read to the end.

Small Accumulators. How Made and Used. Edited by Percival Marshall. Pp. 62. (London: Dawbarn and Ward, Ltd.)

THIS is the first of a series of small and popular scientific manuals for amateur electricians and students. The instructions are sufficient to enable small accumulators to be constructed by readers who have not any previous knowledge of electricity; and for readers who prefer to purchase these appliances, descriptions are given of several forms of storage battery.

Natalité et Démocratie. By A. Dumont. Pp. 230. (Paris: Schleicher Frères, 1898.)

THE six lectures printed in this volume were delivered at the Paris École d'anthropologie during the session 1896–97. They are all concerned with the subject of depopulation in France, variations of the birth-rate in different districts, and the importance of the effects upon national welfare.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Utility of Specific Characters.

In a recent issue of the *Journal of the Linnean Society* (Zoology, No. 172) there is a short paper by my friend Dr. St. George Mivart, in which he gives numerous cases of species of Lories peculiar to various Papuan or Pacific Islands, which differ in some details of coloration from allied species in other islands, while they are usually altogether unlike the other birds inhabiting the same island. He then argues, as Captain Hutton had done with regard to similar phenomena among the fruit pigeons of the genus Ptilopus, that these various specific markings cannot be useful, and especially that they cannot be needed as "recognition-marks," because the whole coloration of the genus is so distinct that they cannot possibly be confounded with any other birds now inhabiting the same islands. He therefore concludes that these facts "are fatal to a utilitarian explanation of the origin of all specific characters." At the same time he accepts evolution and the natural biological origin of these and all other characters. These conclusions appear to me to be wholly illogical and to be reached by omitting to take account of the fundamental idea of organic evolution itself, namely, that each species has been, somehow, developed from an allied but distinct species, living or extinct. I therefore ask leave to point out how this omission affects the problem.

It is quite clear then that each distinct species of lory or fruit pigeon now found isolated from their allies in so many of the Pacific Islands *must* (if evolution is admitted) have originated by modification from some other parent species. The modification may have occurred in another island (or continent) or in the island in which the modified species now exists; but, in either case during the process of differentiation, recognition-marks would be of vital importance by checking intercrossing, so much so that it is doubtful whether in many cases the required structural or physiological modifications could be brought about without them. I do not remember that this proposition has been seriously denied, and it is the omission to take account of it that invalidates the argument of Dr. Mivart and Captain Hutton, founded upon the existing distribution of the species in question.

Perhaps these gentlemen will reply that they hold the views of Romanes and Gulick, that the specific differences in question are the direct result of the action of changed conditions on the progeny of the individuals which first reached the islands; but this theory is a pure assumption in support of which I am not aware that any adequate facts or observations have been adduced, while such changes in *all* the individuals exposed to the influence of the new conditions is entirely opposed to the known facts of variation. Supposing, however, that the existing species originated in the islands where they now occur by modification of some two or more original immigrants, let us consider *how* the change would be effected in accordance with the known facts of variation and natural selection.

The first thing that happens on the introduction of a new form into an island well-suited to it, and with no other enemies than those to which it is already adapted, is to increase rapidly till the island is fully stocked—witness the rabbit in Australia, New Zealand, and Porto Santo, the sparrow in America, and numerous other cases. But as soon as the island is fully stocked and all future increase dies off annually, natural selection begins its work, and the least adapted to survive, in every stage from the egg to the parent birds, get destroyed by some means or other. Now, if this process of elimination is identical in character with that to which the species was subjected in its former home no specific change will take place, because the whole structure and habits which constituted "adaptation to conditions" in its former habitat are equally effective in its new abode. But if there is any difference in the environment which requires a new adaptation, whether as regards food, seasons, diseases, or enemies of other kinds, then natural selection will certainly tend to bring about that new adaptation, and as in such a limited area local segregation will be ineffective, some external indication, marking off the new and better adapted from the old less adapted type, will be of the first importance in the prevention of inter-crossing and thus hastening the process of complete adaptation; and these external indications are what I have termed "recognition-marks." When the new type is fully established and the old parent-form has died out, the work of these recognition-marks will have been done; but having been established by a severe process of selection they have become fixed and continue to form the "specific character" distinguishing the new from the old species. The repeated statement of Dr. Mivart, that in this or that case the peculiar marking cannot be a recognition-mark, or that such "recognition-marks" are quite needless, is therefore beside the question, since the very existence of the new species during the process of differentiation may have depended upon them.

I have here confined myself strictly to the one point raised by Dr. Mivart and Captain Hutton, having already dealt with the general question of "utility" elsewhere.

ALFRED R. WALLACE.

The Duke of Argyll and Mr. Herbert Spencer.

In his review of the Duke of Argyll's "Organic Evolution Cross-examined, &c.," Prof. Meldola describes the Duke as "doing violence to Huxley's teaching," and asks him "in fairness" to "reperuse" something Huxley has written. After recognising the unfairness he refers to, he might not unfitly have suspected unfairness in the Duke of Argyll's representations of my views: especially considering the absurdities ascribed to me. Yet Prof. Meldola says that the Duke "makes some good points out of Mr. Spencer's change of view with respect to the efficiency of natural selection," and represents him as making merry "over Mr. Spencer's abandonment of that excellent child of his creation, the term 'survival of the fittest.'"

Had Prof. Meldola looked into the matter, he would have found that I have in no degree whatever abandoned the term "survival of the fittest." The Duke of Argyll has misrepresented me in a way which is extremely surprising. In the "Factors of Organic Evolution" ("Essays," i. 429-30), after pointing out that the metaphorical character of Mr. Darwin's expression "Natural Selection" is apt to mislead, as he himself admitted, I said that "kindred objections may be urged against the expression 'survival of the fittest.'" I said that "survival" "suggests the human view of certain sets of phenomena" rather than the view of them as physical facts; and I further said that "If a key fits a lock, or a glove a hand, the relation of the things to one another is presentable to the perceptions. No approach to fitness of this kind is made by an organism which continues to live under certain conditions" (p. 430). But there is no admission that the words, imperfectly adapted as they are, fail to express the truth in question with approximate correctness. Any one who will turn to the chapter on "Indirect Equilibration," in vol. i. of the "Principles of Biology" (§ 164), will read as follows:—

"That is to say, it cannot but happen that those individuals whose functions are most out of equilibrium with the modified aggregate of external forces, will be those to die; and that those will survive whose functions happen to be most nearly in equilibrium with the modified aggregate of external forces. But this survival of the fittest implies multiplication of the fittest, &c."

It was in this place and in this manner that the expression "survival of the fittest" arose, and to show that I have abandoned the belief it formulates it is needful to show that I have abandoned the theory of indirect equilibration which it is used to express briefly. I have done nothing of the kind, and there is no sign that I have done anything of the kind.

I am, indeed, not a little astonished that the Duke of Argyll should have reproduced these statements of his after the direct contradiction given to them in my reply to him published in the *Nineteenth Century* for February 1888. At the close of my article, entitled "A Counter Criticism," there occur the sentences:—

"On one further point only will I say a word, and this chiefly because, if I pass it by, a mistaken impression of a serious kind may be diffused. The Duke of Argyll represents me as 'giving up' the 'famous phrase,' 'survival of the fittest,' and wishing 'to abandon it.' He does this because I have pointed out that its words have connotations against which we must be on our guard, if we would avoid certain distortions of thought. With equal propriety he might say that an astronomer abandons the statement that the planets move in elliptic orbits, because he warns his readers that in the heavens there exist no such

things as orbits, but that the planets sweep on through a pathless void, in directions perpetually changed by gravitation."

It remains to remove a misapprehension of Prof. Meldola's own. He says: "It may be well to indicate that many—perhaps we may say the majority of biologists in this country—have long ago parted company from Mr. Spencer on this question of the enhanced importance of 'direct equilibration,' and the subordinate position assigned to 'indirect equilibration' in his later writings." I know of no foundation for such part of this statement as refers to my opinions. That I have not changed my view concerning the respective shares of direct and indirect equilibration there is incontestable proof. If Prof. Meldola will turn to § 170 (p. 468) of the "Principles of Biology," first edition, he will find it there contended that at first "natural selection worked almost alone in moulding and re-moulding organisms into fitness for their changing environments; and natural selection has remained almost the sole agency by which plants and inferior orders of animals have been modified and developed." He will find it further said that in proportion as organisms become complex and active, "the production of adaptations by direct equilibration takes the first place—indirect equilibration serving to facilitate it." And now, if he will turn to the revised edition of the "Principles of Biology" issued last year, he will find that the two sentences quoted stand as they did in 1864.

Prof. Meldola has been misled by a not unnatural illusion. I have of late years had occasion frequently to insist on the share taken in organic evolution by direct equilibration (or the inheritance of functionally-produced changes) because it has been continually denied; and frequent insistence on its share has been mistaken for an alleged extension of its share.

Brighton, January 8. HERBERT SPENCER.

Carte Géologique internationale de l'Europe.

I HAVE just received, through Mr. Edward Stanford, Livraison iii., containing seven sheets of this great work, in which we have the maps of the British Isles, of Germany, Italy, Austro-Hungary and Greece. These maps exhibit a marvellous amount of care on the part of the Directors, and of elaborate execution on the part of Herr Dietrich Reimer and his staff. I do not venture to eulogise, much less to criticise the maps, but only to direct attention to one special point of interest which they exhibit, namely, the representation of the great terminal moraines on both sides of the Alps. It requires a little close scrutiny to discover the course of these great banks of glacier detritus laid down at the epoch of greatest cold of the Glacial Period; but once recognised, it amply repays attention to follow their course. They are represented by lines of purple dots, about three or four deep, lessening in size inwards; and, of course, passing disconnectedly over all the geological formations. On the north base of the Alps the moraine bank starts from above Grenoble, swelling northwards near to Lyon along the Rhône valley; then, retreating southwards, it winds along the flanks of the Jura above the plain of Geneva and Lake Neuchâtel; then passing by Berne and Zürich, stretches away northwards by Schaffhausen and Ravensburg, indicating the enormous extent of the old Rhein Glacier; and then curving outwards along the valleys descending from the eastern Alps by Munich and Salzburg, it is represented as surrounding the northern shore of the Traun See; but no further eastwards.

The northern limit of erratic blocks is represented by a nearly continuous red line extending generally much further from the base of the Alps than is the case with the terminal moraines. Commencing on the west at Grenoble the line curves round by Lyon and Bourg, and then ranging along the Jura Meridional, celebrated for the huge boulders of granite which are there stranded, stretches northwards towards Besançon; thence, skirting the Rhein valley near Basel, the line stretches eastward by Schaffhausen, where it almost skirts the northern base of the moraine, and so passes onwards by Munich to the banks of the Enns by Steyr (Steyer).

The great glaciers which descended from the Alps on the Italian side have (as is well known) left behind them huge moraines, which are also represented in a manner similar to those on the north side. Thus we have the great terminal moraines of the rivers Dorea Riparia and Dorea Baltea near Turin; then, further eastwaid, those which border the southern shores of Lakes Maggiore, Como, D'Iseq and Garda. The southern limit of erratics is only represented at a few places, and then generally in close proximity to the margin of the moraines. The close connection of the great Italian lakes with the moraines cannot be overlooked by those who recognise the evidence adduced by the late Sir A. C. Ramsay in support of his views on the glacial origin of lakes. The moraines of the Dorea Riparia and Dorea Baltea were amongst his favourite illustrations.

Before closing I might be allowed to add that the topography of the map is admirable, while the coloration of the geological formations, except, perhaps, in the case of the British Isles, fully sustains the reputation of the Lithographic Institute of Berlin. EDWARD HULL.

January 3.

Periodic Tides.

CAPT. A. S. THOMSON (p. 125) calls attention in your columns to the subject of short period oscillation of water-level at Malta and Sydney, and asks for further information from others. As I have given some attention to studying similar phenomena on the eastern coast of Canada, I venture to offer the following additional information and suggestion of an explanation.

(1) The phenomena are very common. At St. John, New Brunswick, on the coast of the Bay of Fundy, the oscillations have a fairly constant period of 43 minutes. At Quaco, a few miles further up the bay, the period is only $12\frac{1}{2}$ minutes. At Halifax, Nova Scotia, on the Atlantic coast, the period is $23\frac{1}{2}$ minutes. In the Gulf of St. Lawrence, at South-West Point (Anticosti), the oscillations are rapid but irregular; at St. Paul's Island, very rapid and irregular; at Forteau Bay, small and irregular; at Carleton (Quebec) there is some indication of a 22-minute period; at Souris (Prince Edward Island) the oscillations are rapid and irregular; at Pictou (Nova Scotia), small and irregular: at St. Peter's Island, very rapid and irregular.

(2) Any explanation must account for two distinct things: the *origin* of the fluctuations, and their *periodicity*. Let us take these in reverse order.

(3) The period of the oscillations (where they have a definite period) is, I believe, simply the period of the free natural vibrations of a semi-confined body of water "wish-washing" to and fro like water in a wash-bowl, the oscillations being sometimes *fundamental*—that is, consisting in the vibration of the body of water as a whole; and in other cases (perhaps the majority of cases) *partial*—that is, due to the body of water dividing up into two vibrating halves, or three-thirds, &c. In a very irregular basin, like the Gulf of St. Lawrence, regular vibrations are impossible. In some other cases the basin is of sufficiently regular form to admit of fairly regular oscillations, but not regular enough for the period to be deduced mathematically. In only two cases have I found a mathematical test possible. At St. John, the Bay of Fundy is bounded on one side by the slightly indented New Brunswick coast, and on the other side by the straight, abrupt Nova Scotia coast, these two shores being only slightly inclined to one another. The width may be taken as forty miles, and a study of the chart gives the mean depth *at low tide* as 34·4 fathoms. The period of fundamental vibrations across such a basin is given (to a sufficient approximation) by

$$t = \frac{2l}{\sqrt{gh}},$$

l being the width, and h the mean depth. With the above figures, this gives for fundamental vibrations a period of 87 minutes, and for first partial vibrations a period of 43·5 minutes. The latter is remarkably close to the observed period of 43 minutes. It should be noted that the calculation applies to low tide. Now, the tide at St. John has a range of 20 feet, while the formula shows that the period vaiies inversely as the square root of the mean depth. A simple calculation shows that the period at high tide should be two minutes less. From an examination of all the cases available, I found that the mean period for high tide was actually 1·6 minutes shorter than for low tide; but the fewness of the well-marked cases available to me for making this test (thirteen in all) makes me believe that this agreement is somewhat accidental.

The other case known to me to which a similar calculation can be applied, is that of a small basin in the St. John River, just before it flows through a very narrow gorge into the harbour. While using a rough form of self-recording tide gauge for finding accurately the time of high water, I discovered on the

record, not only the above-mentioned 43-minute oscillations, but also a series of much more rapid oscillations having a period of about 35 seconds (the latter figure being obtained by a stop-watch). The width of the basin is, at the point of observation, 2030 feet, and its mean depth about 100 feet (the tidal range is less than 2 feet). Calculation by the above formula gives, for first partial vibrations, a period of 35·8 seconds, which is very close to the 35 seconds observed; but it is to be noted that for a basin whose depth is *not* small compared with its width, the above formula is somewhat in error, and a more correct formula (involving a hyperbolical cotangent) gives 37·5 seconds. In any case the agreement is striking, and the two instances given are almost conclusive as to the explanation advanced. Simultaneous observations on opposite sides of such a basin would be quite conclusive, but these I have not yet had an opportunity to make.

(4) The following notes on the other cases referred to in (1) may be of interest in connection with observations referred to by Capt. Thomson. Quaco is only about twenty miles further up the Bay of Fundy than St. John, and yet, while expecting to find there a period similar to that at St. John, I found a period of 12½ minutes (from four separate records). This was at first puzzling, but, later, an examination of the chart showed the existence of a dangerous ledge (the Quaco Ledges) coming nearly to the surface, at a distance of eight or ten miles off shore, and forming, with a headland above Quaco and another below, an irregular basin, the dimensions of which no doubt determine the period of oscillation. A quite similar explanation applies to the oscillations at Halifax, for there a succession of banks (the Emerald, Sable Island, Le Have and Roseway) form, with the Nova Scotia coast, a large-sized bay of irregular shape.

(5) As to the external impulse that starts the oscillations, there is much uncertainty. Marked oscillations at St. John are frequently accompanied by barometric disturbances, but not always. My own observations make me believe that the oscillations and heavy ground-swell usually coexist. A notable case (for which I have to thank Mr. S. W. Kain, of St. John) occurred on September 18, 1898, when the heaviest ground-swell in several months was accompanied by marked periodic oscillations recorded on the Kelvin gauge. On the whole, I believe that the disturbance of equilibrium is due either to abrupt local variations of atmospheric pressure, or to the transmitted effect of a distant hurricane.

Those who are interested in this subject will find fuller details of the cases here discussed numerically (and also a short bibliography of the subject) in a paper by myself in the *American Journal of Science* (vol. iii., 1897). The nature of the oscillations in the Gulf of St. Lawrence are shown on curves that illustrate a tidal report, by Mr. W. Bell Dawson, in the last volume of *Transactions* of the Royal Society of Canada (see NATURE, vol. lviii. p. 260).

A. WILMER DUFF.

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GENERAL LAW OF THE PHENOMENA OF MAGNETIC PERTURBATIONS OF SPECTRAL LINES.

In the *Philosophical Magazine* for April 1898, I pointed out that the resolution into triplets, &c., which the spectral lines suffer in a strong magnetic field, did not appear to follow any obvious general law, but appeared to be some complex function of the wave-length. To this was added the following remark: "It is possible, however, that the lines of any one substance may be thrown into groups for each of which $\delta\lambda$ varies as λ^2, and each of these groups might be produced by the motion of a single ion. The number of such groups in a given spectrum would then determine the number of different kinds of ions in the atom or molecule.

"Homologous relations may also exist between the groups in different spectra, but all this still remains for complete investigation."

Although this investigation is still far from complete, yet the measurements so far made uniformly go to show that the foregoing expectation is about to prove true, and that e/m or $\delta\lambda/\lambda^2$ is the same for the corresponding lines of the natural groups in the same spectrum, and, further, that this quantity remains the same for corresponding lines or groups in the homologous spectra of different substances.

Not only is the magnitude of the magnetic effect governed by the foregoing law, but the *character* also of the effect is the same for the corresponding lines; and this is very interesting, as it shows that the corresponding lines probably arise from the same origin. The theory is consequently verified by the facts when the spectral lines are considered in groups corresponding to the molecular events which produce them.

THOMAS PRESTON.

COAST-TELEGRAPHS AND SPACE-TELEGRAPHY.

THE year 1898 was an important period in the history of space-telegraphy, it was the period in which the possibility of being able to signal across wide stretches of open sea, with certainty in all weathers and at high speeds, became first generally recognised as practicable. Within the year the final report of the Royal Commission on the question of Coast-Telegraphs, published late in 1897, came into our hands; and the last few months of the year witnessed a truce to the war of "wireless-telegraphy." A wave of good feeling has now united the opponents into something like coherence, and the honours have been divided with universal approval. The result is that for the future Italy takes prominence, England eminence, while Russia, Germany and France share the luxury of many grievances.

The close of the year is very appropriately characterised by three papers, respectively communicated by Dr. Lodge,[1] Mr. W. H. Preece,[2] and Mr. S. Evershed,[3] to the Institution of Electrical Engineers, all emphasising the merits of one and the same system of space-telegraphy. The authors themselves were more or less unanimous as to the course further experiment should take, but the discusssion that followed the reading of these papers showed a certain lack of directness; many of the speakers were carried away by side issues, and a great deal of time was occupied with ill-considered suggestions and old matter. While fully recognising the value of open discussion, and of hints thrown out at random on subsidiary matters, the present writer thinks it may be useful here to indicate the limits to which the problem may be narrowed down, and to point out the very serious work that is now calling for the aid of space-telegraphy.

It is very generally admitted that space-telegraphy will replace metallic-circuit systems only under conditions where metallic circuits are impracticable. The fact that metallic circuits have been laid over the Andes, may be taken as proof that there are remarkably few land-areas that cannot be spanned by wires. For communication between *fixed* points on rough coasts, a wire suitably protected is still the right and the best thing, as is evidenced by the cable[4] laid in 1890 between Pollagill Bay on the north-west coast of Ireland, and Portdown Bay, Tory Island, and thence by duplicate underground cables to the lighthouse on the north side of the island. The great advantage of a metallic-circuit system is the consequent privacy of the messages, the simplicity of the apparatus, the speed of transmission, and the possibility the system offers for working by telephone, and in other ways avoiding the expense of skilled operators. Space-telegraphy is at present limited to comparatively short distances, and its usefulness is confined to spanning estuaries, skirting sea-boards, and for such purposes as

1 "Improvements in Magnetic Space-Telegraphy."
2 "Etheric Telegraphy."
3 "Telegraphy by Magnetic Induction."
4 See an important paper by Mr. H. Benest, "Coast-Telegraph Communication," read before the Balloon Society, March 18, 1892).

that to which it was applied by Mr. Preece between Oban and Mull in 1895. But, except in rare instances, it is only likely to replace submarine cables between moored vessels and the shore, *e.g.* between light-ships and the coast-guard stations. The point of failure in submarine-cable communication thus happens to coincide with the point of favour of space-telegraphy. The present object of those working at space-telegraphy should therefore be to supplement the cable-system of coast telegraphs, so that all the light-vessels and lighthouses of our coasts may be brought into communication with one another and with the life-boat stations.

Some idea of the scope of the work of completing our coast-telegraphs may be gathered from the fact [1] that the whole number of distinctive lights, including port, harbour, and pier lights, light-vessels, and lighthouses on the coasts of the United Kingdom in October 1898 was 1095, and at the beginning of that year only[2] 51 light-vessels and light-ships were in communication with the telegraphic system. Three additional lighthouses, *i.e.* those at Godrevy, the Skerries, and Walney Island, were connected to the shore during last summer; but pending [3] further results of the experiments with the system of "wireless-telegraphy," it was thought better to postpone the work of connecting moıe light-ships to the shore by electric cables. These lighthouses and other sea-marks are maintained out of the fund [4] derived from lighthouse tolls, which amount to over 500,000*l.*, the lighthouses, &c., being thus self-supporting. This fund has lately been augmented by a special grant; with a view to increasing the efficiency of the system.

The hard task of establishing communication with a light-ship moored in a tide-way, successively rising and falling at each tide, swinging, rolling, and pitching, and in other ways gesticulating around her uncertain anchorage, has taxed the resources of cable engineers for the last quarter of a century. The system now generally adopted consists in the use of a swivel[5] or toggle having a hollow spindle so as to allow a telegraph-cable to be passed up through the middle of it. This swivel is placed between the ship and her moorings at about the water-line. One or more chains lead down from "eyes" on the swivel to the mooring anchors; there are generally two such chains, or there may be three, spread out tripod-fashion, to terminate in mushroom anchors. A riding-chain leads upwards from the swivel, and is secured to the vessel in the ordinary manner after passing through the hawse-pipe; the cable is hauled on board through the hollow swivel, over a sheave and on to a drum, which can be turned round by hand as required, to take the twists or "turns" out of the cable as they are formed. A special veering-drum has been designed by Mr. Benest,[6] by means of which this operation of taking out "turns" is performed automatically by a special gear on the drum. Electrical communication is maintained through the axes of the drum by brush-contacts or otherwise. In rough weather the riding-chain is generally veered out, sometimes up to fifty or sixty fathoms; and after a gale it is often found in tangled masses, which are sometimes as large in girth as that of a man. The cable itself, if it has not been entangled, has meanwhile been saved from kinking by the swivel device, but it suffers a good deal from the threshing and flattening against the bottom, from friction at the swivel, and occasionally from fouling the chains. An ingenious type of veering-cable has been designed by Mr. F. C. Crawford,[7] which is built up in such a way that it is very difficult to make a kink in it. To secure this result, the stranded conductor

1 *Liverpool Mercury*, October 26, 1898.
2 Report of the Royal Commission, September 1897.
3 *Times* House of Commons Report, July 1, 1898.
4 *Imperial Institute Journal*, March 1896.
5 See Bedwell's Patent, No. 367, 1876.
6 Patent, No. 19,646, 1895. 7 Patent, No. 21,657, 1895.

of seven-tinned copper wires is covered with india-rubber and lapped with cotton tape to make a bedding for the sheathing wires. The sheathing consists of twelve double-tinned steel wires, each coated separately with india-rubber and tape. Finally there is an outer serving of india-rubber, which encloses everything into a compact form, and, while allowing the requisite amount of flexibility,[1] prevents the sheathing wires from slipping over one another when the cable is bent. As a further protection, especially against the "threshing" action, this veering-cable is occasionally threaded with beads or ferrules of lignum vitæ, or with washers of india-rubber.

Another metallic-circuit method has been tried at Sandy Hook,[2] in which use is made of the mooring chains themselves as a means of connecting a telephone in circuit from the vessel to the cable. This method is reported upon very favourably by its designers, Messrs. Blake and Caldwell, but in their account of it the conditions are not very fully elaborated. The present writer made some experiments in this direction some years ago, and came to the conclusion that the conductivity of such chains was too variable to be trusted. His tests showed that a mooring-chain of 2-inch links and $\frac{1}{2}$-inch iron, 12 fathoms in length, after being pickled in tar, dried, and slung up in the air, had a resistance of 9 megohms when tested with 100 volts; when tested with 750 volts the resistance broke down to 400 ohms. A similar chain, dry and somewhat rusty, had a resistance of 850 meghoms. When dipped in water and again slung up, the resistance of the 12 fathoms was 25,000 ohms. Chains sagging in water were able to transmit telephone currents with a battery of a few volts. Two mooring-chains, of the same dimensions as those described above, were carefully tarred, and the contacts at the links were cleaned bright over a small area. The chains were then paid out from the shore parallel to one another, 8 feet apart, in about 2 fathoms of water in the Thames, the distant ends being hauled on to a barge. Telephoning between the barge and the shore was impossible, even with 100 volts in the circuit. All the electricity passed from chain to chain by way of the water. Brass chains had, of course, much lower resistance than the iron chains; the resistance of brass chains was practically the same, wet or dry. But it was always found that with any chain whatever in the circuit, the loose contacts caused "buzzing"[3] in the telephone. It is possible that Messrs. Blake and Caldwell used chains under great stress, or that they used some special device, but in view of his own experiments the present writer does not regard the chain system as a practicable one.

Some years ago an alternative method of connecting a light-ship to a telegraph cable was suggested by Mr. James Wimshurst. He arranged a swivel which contained two flat coils, a primary and a secondary, placed one over the other, so that one could rotate coaxially upon the other, for the purpose of avoiding kinks as the ship swings about. As a matter of fact, the danger does not depend so much upon the twist, as upon the threshing action due to the rise and fall of the cable. Mr. Wimshurst's suggestion is worthy of a trial, but it must be remembered that the swivel, in the form proposed by its designer, meets only a very small part of the difficulty.

This short review of metallic-circuit and allied direct-cable methods, serves to show that the attempts made in this regard by the Royal Commission have only resulted in partial success.[4] While admitting that the problem is now fair game for the space-telegraphers, the present

1 This cable is in use at Formby Light-ship, with very satisfactory results.
2 Annual Report of the Lighthouse Board of the United States, June 30, 1895.
3 See *Electrical Review*, vol. xxvii. p. 57 and p. 656, 1890; also May 14, 1897.
4 *Standard*, Friday, February 1, 1895: "The Ramsgate life-boat and tug *Bradford* proceeded to the Goodwins, in response to signals of distress from the lightship; the lightship telephone having, it is understood, got out of order."

writer would point out that the resources of cable engineers in devising direct metallic-circuits are by no means exhausted. There is a singular lack of evidence on this point in the Blue Books; the Royal Commission seems to have swung about a good deal on its own small swivel, with something very like disregard for outsiders. For some reason, perhaps unknown, they failed to call as witnesses the very men whose experience would have made for success. In departing from these older methods, it must not be forgotten that we are departing from all the advantages offered by the telephone; skilled operators will have to be requisitioned, and there will be need for a delicate device for "calling-up" the operator.

The fourth Report (dated May 12, 1896) of the Royal Commission concluded with a very hopeful note on a contemplated trial of an "inductive method" suggested by Mr. Evershed. "Under this system," it says, "the cable running from the shore is laid in a circle on the bottom of the sea immediately under the light-vessel, the circle having such an area that the vessel will always be within the circumference of it. Round the deck of the vessel a number of 'turns' of insulated wire are coiled, which are in connection with a telephonic receiver on board ship. This system has not yet (May 1896) been subjected to a practical test at a light-ship."

The fifth and final Report of that same Royal Commission (September 1897), referring to the trial, observes that "the experiment was carried out in August 1896 at the Goodwin (North Sand Head) light-vessel, but after a careful trial it proved a failure. The apparatus had been tested on shore with satisfactory results, but when it was tried at the light-vessel, which is moored in ten fathoms of water, it was found almost impossible to effect communication by means of it, the electric energy being almost entirely lost in the sea. The difficulties experienced were entirely electrical."

In the following year a mathematical investigation as to the cause of this failure was undertaken by Mr. C. S. Whitehead (*Proc. Phys. Soc.*, vol. xv. pt. xi. pp. 188–200, 1897); it was communicated to the Physical Society in a paper read June 11, 1897. His theoretical results show that if his calculations are correct, the normal magnetic induction of the primary coil loses 79 per cent. of its initial value in passing to the secondary through ten fathoms of sea-water. These figures as to the absorption-factor of sea-water have been criticised by Mr. Oliver Heaviside and by Dr. Oliver Lodge. In the meantime Mr. Evershed has turned his attention to improving his apparatus. In his recent paper he regards the inductive coils as a particular case of a dynamo-electric machine, he neglects the absorption-factor, and gives an expression for the power available at the receiving station for ultimate conversion into motion at the receiving instrument. The result arrived at is that the mechanical power is independent of the number of turns into which the total volumes of copper are divided on the primary and secondary circuits, and that the two circuits should have equal volumes of copper. His assumption at the outset, that the use of two horizontal circuits implies a loss of one-half the mutual induction between them, may have to be modified. Perhaps the most important part of Mr. Evershed's paper is his description of a "call" or receiving apparatus, which enables exceedingly minute currents to be detected. From a remark in his paper, he does not appear to be aware of the work that has been done in America by Lucien Blake and Eugene Caldwell in their attempts to provide an instrument to replace the telephone. In the Annual Report of the Lighthouse Board of the United States (June 30, 1895, p. 37) will be found an account of a calling device. This Report says: "The receiving apparatus or relay for this system would be vibratory in character and tuned to a frequency of vibration to correspond with the period of the calling current. In addition to this mechanical adjustment, the electrical circuits might be adapted by the use of condensers and inductances to respond more readily to alternate currents of the same period. The action of such a system would be cumulative, *i.e.* each successive impulse of current would arrive just in time to increase the vibration in the relay until sufficient amplitude would be obtained to operate a circuit-closing device." This report also touches upon an interesting point raised by Sir Henry Mance in the recent discussion. With regard to the sensitiveness of "calls," it observes that "a careful study of all kinds of instruments in which weak alternating currents produce mechanical movement, shows that by far the most efficient are those in which the current does not produce an alternating magnetic field, as in the electrodynamometer, but operates to increase and decrease the strength of field of a permanent magnet. The mechanical motion produced by such polarised machines is always vibratory. Careful measurements in the laboratory show that this relay will work positively with a current representing 0·0001 watt, and that it can be operated with much less energy than this." This report seems to have escaped the attention of Mr. Evershed; he suggested in his recent paper that so far as he was aware the ordinary Bell telephone has been exclusively used as the receiving device in this class of experiments. There is, of course, no question as to priority; Mr. Evershed was using a vibratory indicator on this synchronous principle in 1892, the American report refers to an instrument designed in 1895. In his latest (1896) form of apparatus, Mr. Evershed duplicates the vibratory metallic rectangles; they are connected to two separate secondary circuits in such a direction that they oscillate in opposite phases in a strong magnetic field. This arrangement has the advantage that when the twin rectangles are in unison it is almost impossible to bring them into contact by shaking the instrument.

Mr. Preece's paper is a history of the experiments made by himself and his staff, since 1885, on "the electromagnetic form of ætheric telegraphy," *i.e.*, on the method of signalling between one alternate current circuit and another. This work has been more or less familiarised to us by the newspapers. He used horizontal coils of large diameter at the sending and receiving stations, but they were regarded as "impractical things" and they were replaced by straight conductors, placed in parallel planes, one at each station. Capacity and self-induction were eliminated. An interesting series of experiments is described, in which two earth-plates are buried at a distance apart in the earth; the lines of electric "flow" are traced, and the locus of a hypothetical resultant-conductor is plotted. Incidentally, Mr. Preece makes the curious statement that "we know *by Ohm's law* that the resistance of a circuit increases with its specific resistance and length, and diminishes with its sectional area." By Boyle's law this involves a misconception! Of the various arrangements of inductors for his mode of signalling, Mr. Preece prefers parallel wires connected to earth at each extremity, the wires being carried to a considerable height. The most satisfactory results were obtained over a distance of 3·3 miles across the Bristol Channel; and when it is remembered that the speed of signalling is practically as high, and that the system is as certain and as efficient as the ordinary metallic circuit system, this result must be regarded as the best so far brought to notice.

The question naturally occurs to us at this point, What then has become of the "coherer" systems? Mr. Preece[1] has recently said that the Marconi system is able to traverse a distance of twenty-five miles; but on the same occasion he mentions that there would be no difficulty in communicating by the alternate-current inductor system over a similar distance. Hence there

[1] *The Engineer*, November 25, 1898.

is little to choose on the merit of distance. On the other hand the speed of signalling by the "Marconi" system is limited to something like twelve words a minute, and we must conclude that it is this circumstance that handicaps the method. It is also probable that "coherer" systems are at present too susceptible to mechanical and fortuitous electrical tremors for the ordeal of a telegraph office, but in the absence of evidence it is perhaps scarcely fair to draw comparisons in this regard. According to the *Times* of Monday, the 9th inst., arrangements are being made under the direction of Signor Marconi at the South Foreland lighthouse, and aboard the South Goodwin light-ship, for a series of experiments with his apparatus. It is stated that if the system is found satisfactory it will forthwith be adopted between those points —the distance between them is about three miles.

Two articles in the *Electrician* of November 12, 1897, one by Dr. Lodge[1] and the other by Mr. A. C. Brown, should be referred to as indicating the extent of the work done and the hopefulness of the votaries of "coherer" systems at that time. Later developments of the "coherer" system, particularly in the matter of syntony and the best arrangement of contacts, are dealt with by Dr. Lodge in a communication to the Physical Society of January 21, 1898, an account of which appeared in NATURE in February 1898. The possibility of individualising signals by syntony on Dr. Lodge's system is discussed in an excellent article in the *Electrical Review* of August 19, 1898, which is prefaced by some remarks that already show the weak points of "coherer" systems. Messages had then been sent by Marconi over a distance of about sixteen miles, and received in "dot and dash" on the Morse ribbon at a rate of something under twelve words a minute; but it had been found in practice that the principle of resonance could not be applied with sufficient effect to ensure that messages should be recorded only by a single selected receiver. Whether the later more elaborate methods of syntony for "coherer" systems, proposed by Dr. Lodge, have justified themselves in practice is not yet known, but it is a significant fact that Dr. Lodge's most recent paper on the subject of space-telegraphy makes a distinct departure from the "coherer" system, and contains no account of experiments in the direction of syntonised receivers used in this particular way.

In 1898, experiments as to the mysterious connection between "coherers" and photo-electric phenomena made little progress towards a practical system of telegraphy. In the hands of Prof. Minchin these experiments, at the outset, showed great promise; they gave us the "collecting wire" which, protruding into space, acts as a "feeler" for Hertz waves, but at present they remain as toys of the laboratory. The so-called "Lichtelektrische Telegraphie" of Prof. Zickler, of which a very good account is given in the *Elektrotechnische Rundshau*, No. 21, pp. 232-233, 1898, is more pretentious as a means of signalling. Prof. Zickler makes use of an old discovery, due to Hertz, that ultra-violet light is able to reduce the spark-resisting power of an air-gap. He directs a beam of light from an arc lamp, provided with a shutter, upon the extended spark-gap of an induction coil, and by opening and closing the shutter causes sparks to pass at the gap at corresponding intervals of time. These sparks affect a "coherer" circuit, and signalling is rendered possible. Such experiments are very attractive from a purely scientific standpoint, but it is not easy to see the advantage of this method as compared to the ordinary heliograph. Using the simplest form of apparatus, Prof. Zickler succeeded in signalling by this means across a space of two metres; and by the aid of an arc lamp that expended nearly two horse-power, and by the use of quartz lenses, that distance was extended to 200 metres. The speed of receiving the signals is not mentioned; the extreme limit is probably about twelve words a minute. He proposes to apply the system to lighthouses and to fortresses. We admit that such a system would be admirably suited for the purpose of warning our *foes* off dangerous parts of the British coasts; but for the purpose of warning our own or friendly ships, a surer means of communication must be adopted.

[1] By a slight error, Dr. Lodge there attributes an experiment on liquid "coherers" to Lord Rayleigh. This experiment was first described and shown by the present writer on March 26, 1897, at the Physical Society. A few weeks later it was *repeated* by Lord Rayleigh at the Royal Institution.

Comparing the various methods,[1] and keeping in mind that we are here concerned with a practical question for engineers, rather than with the scientific aspect of space-telegraphy, it would seem that the "coherer" systems as a whole are about to be cast aside, and that preference is to be given to alternate-current inductor systems for coast-telegraphs. If this is indeed to be the case, the problem is greatly simplified, and experiment resolves itself into the single task of finding the best design of apparatus for communicating between a moored light-ship and the shore by means of inductor coils. Dr. Lodge's paper on "Improvements in Magnetic Space Telegraphy" gives us what may be regarded as the academical aspect of that task; he describes a new receiving device for magnetic induction telegraphy, and he explains the method of putting it into practice. The principal feature of this device is the outcome of an electric resonance experiment first described in NATURE, vol. xli. p. 368, eight years ago—namely, the experiment of syntonic Leyden jars. Dr. Lodge now replaces the jars by condensers, and the "tuned circuits" take the form of horizontal coils of wire. The inducing coil is connected to an alternate-current dynamo, and the induced coil is connected to a train of telephone relays, the last of which is thus set into violent action at each received impulse. The paper includes the theory of two such circuits arranged in mutual syntony, and it is full of information and suggestions as to the proper course future experiment should take; the advantage of syntony is discussed, and the relative importance of conduction and induction is considered together with a detailed investigation of the theory of "detectors" for such a system.

The absorption-factor in the case of sea-water will probably be one of the first matters to be dealt with by experiment and theory in the present year. By the use of horizontal inductor coils, one on the light-ship and one ashore, Dr. Lodge avoids the practical difficulty; nevertheless the problem is sure to elicit his interest. Mr. Whitehead, holding tacitly to Maxwell's equations, deduces a law for the absorption-factor, and to this law Dr. Lodge takes exception. Maxwell supposed that the total current was made up of the polarisation current and the induction current; Mr. Whitehead assumes that the polarisation current may be neglected, and that provided the frequency is not comparable with that of light, no serious error can arise from that assumption. Do Maxwell's equations fail then for such a case? Dr. Lodge seemed unwilling to admit that they do fail; he suggested that Mr. Whitehead had written them down in a form that did not agree with Maxwell, and that Prof. J. J. Thomson had written them in yet another form. Mr. Whitehead now asks Dr. Lodge what is the right form? And that's how the matter stands.

ROLLO APPLEYARD.

THE FISHES OF TANGANYIKA AND OTHER GREAT LAKES.

THE first part of the fifteenth volume of the *Transactions* of the Zoological Society of London, which has just been issued, is devoted to a report by Mr. G. A. Boulenger, F.R.S., on the collection of fishes made by

[1] For the various methods of space-telegraphy, see a paper by Dr. S. P. Thompson (*Soc. Arts Journal*, 46, pp. 453-460, 1898.

Mr. J. E. S. Moore in Lake Tanganyika during his recent expedition to Eastern Africa. As Mr. Moore has shown in our columns (NATURE, vol. lviii. p. 404), there are two faunas in Lake Tanganyika, the normal fresh-water, and what Mr. Moore proposes to call the "Halolimnic" group, the latter being evidently of marine origin. That this is the case has been conclusively shown by Mr. Moore's studies of the splendid collection of molluscs which he obtained in that lake. It would therefore be naturally expected that the results of the examination of Mr. Moore's fishes, which has been undertaken by Mr. Boulenger, would likewise show the presence in Lake Tanganyika of a certain number of "Halolimnic" or marine fishes. This, however, does not prove to be the case. Mr. Moore's fishes, Mr. Boulenger informs us, do not yield any such startling results as the mollusca and other invertebrates. The fishes of Tanganyika, though very novel and very remarkable, do not embrace any marine forms. This may be due, as Mr. Boulenger observes, either to the origin of the present fish-fauna not reaching as far back in time as that of the molluscs, or to the incompleteness of Mr. Moore's series. The latter explanation is probably the correct one, as Mr. Moore met with great difficulty in dredging in the deeper water of Tanganyika, only one fish having been obtained from a depth of about 400 feet. This (*Bathybates ferox*), although of a new genus and species, belongs to the widely-spread African family Cichlidæ.

Altogether, the fishes obtained by Mr. Moore in Lake Tanganyika are referred by Mr. Boulenger to thirty-five species, belonging to the families Serranidæ, Cichlidæ, Mastacembelidæ, Siluridæ, Cyprinidæ, Characinidæ, Cyprinodontidæ and Polypteridæ. It would thus seem that in general characters the Tanganyikan fish-fauna, so far as it has been yet ascertained, does not materially differ from the fish-faunas of the other great African lakes, but that most of the Tanganyikan species and many of the genera are distinct, the family Cichlidæ alone having furnished types of ten new genera in the present collection.

In his introductory remarks to the present memoir, Mr. Boulenger has taken the opportunity of putting together lists of the fishes already known to be found in Lake Nyasa, Lake Tanganyika, Lake Victoria and Lake Rudolph. From the first of these we are now acquainted with thirty-seven species, from the second with forty-three, from the third with only nineteen, and from the fourth (Lake Rudolph) with only nine. These lists, Mr. Boulenger points out, must be taken as giving a very inadequate idea of the piscian inhabitants of the great African lakes, owing to the manifest incompleteness of the collections upon which they are based. Of the other lakes nothing whatever, unfortunately, can be said at present, only one species of fish having been yet brought from the great Albert Nyanza. It is evident, therefore, that there is a fine field for the enterprising ichthyologist in the great African lakes.

PROFESSOR ALFREDO ANTUNES KANTHACK.

BY the death of Prof. Kanthack the science of pathology has lost one of its ablest and most indefatigable exponents, and the University of Cambridge, for the second time in less than fifteen months, a brilliant occupant of its chair of Pathology.

At the closing meeting of the Pathological Society, last summer, it was noticed by several of Prof. Kanthack's friends that he appeared to be less energetic and vigorous than usual. After this the work of the long vacation appears to have told upon his health so seriously, that even during the course of a short holiday it was remarked at the opening of the Pathological Laboratories at Liverpool that he still appeared to be far from well. In spite of this few were prepared to learn, about the middle of December, that Prof. Kanthack was suffering from a malignant growth, the symptoms of which had first been indicated by jaundice and severe abdominal pain—a diagnosis that was afterwards confirmed. He died on December 21, 1898.

Alfredo Antunes Kanthack was the second son of Emilio Kanthack, Pará, Brazil, and Victoria his wife, both born in Pernambuco. He was born at Bahia on March 4, 1863, and spent the first few years of his life in Bahia and Ceará, Brazil. He was brought to Germany in 1869, being placed under the care of Pastor Hoppe of Artlenburg on the Elbe, father of the present Prof. Edmund Hoppe of Berlin. In 1870 he was sent to Hamburg, where he was first taught by a strict disciplinarian, "a tyrannical pedagogue but excellent teacher of elementary subjects." During this period he is described as "being by no means brilliant but extremely diligent." Early in 1875 he went to school in the Wandsbeck Gymnasium, near Hamburg. In 1876 he was transferred to the Gymnasium of another Prussian Government school at Lüneburg, and in 1878 to the Gymnasium at Gütersloh, where he greatly distinguished himself. In 1881 he came to Liverpool, where his parents were then residing, and continued his studies for a short time in the Shaw Street College (Classical Department). In 1882, after passing his University of London matriculation examination, he commenced his arts curriculum, and continued his studies in science and medicine under Mitchell Banks, Caton, Mott and other well-known teachers of the Liverpool medical school, graduating B.A. in 1884, B.Sc. in 1886, M.B. and B.S. (in each instance with honours), F.R.C.S. Lond. in 1888, and M.D. Lond. in 1892; whilst in 1897 he proceeded to the degree of M.A., and became a Fellow of the Royal College of Physicians, London. After completing his medical curriculum Dr. Kanthack, in 1889, proceeded to Berlin, and there, as part of the result of his studies under Virchow and Krause, he contributed an admirable paper to Virchow's *Archiv* on the histology of the larynx, a paper which at the time gave rise to a lively controversy, Dr. Kanthack maintaining his original thesis with marked ability and success. Whilst in Berlin, too, he worked under Koch, and here, as in the pathological laboratories, he attracted the attention and received the special encouragement of his teacher. Shortly after his return from Berlin, and probably as the result of an expression of opinion on the part of his teachers—Virchow and Koch—he was appointed one of the Special Commissioners along with the late Dr. Beaven Rake and Dr. Buckmaster, by a joint Committee of the Royal College of Physicians, the Royal College of Surgeons and the Executive Committee of the National Leprosy Fund, to investigate the prevalence, the pathology and the treatment of leprosy in India.

In 1891 Dr. Kanthack was appointed John Lucas Walker Scholar under the late Prof. Roy, and in succession to Dr. William Hunter. During the time that he held this scholarship in Cambridge, he published, along with Mr. Hardy, a paper on the wandering cell in the mammalia, in the *Journal of Physiology*, and a paper on the behaviour of wandering cells, in the *Proceedings* of the Royal Society, vol. lii. These papers are of special importance as indicating that, although thoroughly acquainted with Metschnikoff's work and all that that author had to advance in support of his phagocytic theory, Dr. Kanthack had made, during his stay in Germany, an accurate forecast of the destination to which the work that was being carried on in Germany by Koch's pupils

would eventually lead. During this period, too, he carried on an investigation on Madura Foot, and compared mycetoma with actinomycosis; this paper appeared in the *Journal of Pathology* and in the *Transactions* of the Pathological Society. In 1892 Dr. Kanthack became medical tutor at the Royal Infirmary, Liverpool, and in order that his bacteriological training might be utilised, a special demonstratorship of bacteriology was founded for him. The following year the authorities at St. Bartholomew's Hospital retained Dr. Kanthack's services as director of the Pathological Department in the School and Hospital and Lecturer on Pathology and Bacteriology; and a year later gave him the appointment of Curator of the Museum. In addition to the teaching and routine work of this period he contributed numerous notes and observations to the *Transactions* of the Pathological Society, and, probably for the purpose of systematising his teaching work and saving time in the explanation of details, he in 1894 published, in conjunction with Dr. Rolleston, a "Manual of Practical Morbid Anatomy"; and in the following year, along with Dr. Drysdale, a work on "Practical Bacteriology." Both these works give evidence of wide reading and of an accurate knowledge of literature thoroughly up to date. When Prof. Roy became so ill that it was evident that he could no longer carry on his professorial work, and in all probability would never again be able to take up the duties of his chair, Dr. Kanthack was appointed Deputy Professor of Pathology. The work of this post he carried on simultaneously with his duties at St. Bartholomew's Hospital, making the return journey between London and Cambridge several times a week. This, for a man who, a short time before, had recovered from a severe attack of typhoid fever, involved a very great physical strain; and early in 1897 Dr. Kanthack resigned his post at St. Bartholomew's and gave undivided attention to his work in Cambridge, where, on Prof. Roy's death, he was appointed Professor of Pathology.

Of Prof. Kanthack's influence on the study of pathology and bacteriology in this country, it is as yet too early to speak, though there can be little doubt that, apart from the work that he himself initiated, that of his pupils must ultimately leave a deep impress on the scientific medicine of our time and that immediately to follow. In many ways Prof. Kanthack was an ideal teacher. He exerted great personal influence over the young men who were brought into contact with him. His reading was very wide, so that, possessing a retentive memory, he was able to store up an enormous amount of accurate information which he could always bring to bear on the work that he had in hand. He was thus able to make a profound impression on his pupils. He had a sufficient amount of dogmatism in his manner and method to inspire them with confidence in his teaching, and to give those who were looking to him for guidance a sheet-anchor to which they might hold until they were thoroughly able to take their bearings for themselves. From his extensive reading, too, which, as already indicated, was always kept well up to date, he was able to determine at once what special points remained to be worked out in connection with the various subjects occupying the attention of the scientific world; whilst his keen critical faculty enabled him to mark the flaws in experiment or argument in published work that came under his notice, so that he was always able to set his pupils on to work which should shed some new light on the various questions attacked, and to gather facts and information which would help him in the solution of the problems on which he himself was engaged. Those of his pupils who knew him best regarded him with feelings of the deepest affection—to them the loss is intensely personal. In 1895 Prof. Kanthack married a Liverpool lady—Miss Lucie Henstock—the daughter of the late John Henstock, Esq., of Liverpool.

NOTES.

IN retiring from the presidential chair of the Paris Academy of Sciences, at the meeting on January 2, M. Wolf referred to the changes which had occurred in the list of members and correspondants during last year. In the section of geometry, Prof. Cremona was elected correspondant in succession to Prof. Brioschi. The section of astronomy lost M. Souillart, and the two vacancies caused by his death and that of Dr. Gould, have not yet been filled up. There is a vacancy in the section of geography and navigation, caused by the death of M. Manen, and also a vacancy in the section of chemistry, caused by the death of Prof. Kékulé. In the section of mineralogy, M. Depéret was elected to succeed the late M. Pomel, and Prof. Marsh to succeed the late Prof. Hall. There are two vacancies in the section of botany, one caused by the death of Baron von Mueller. The section of rural economy has lost Marquis Menabrea and M. Demontzey by death, and the vacancies have not yet been filled up. Two vacancies also exist in the section of anatomy and physiology, on account of the deaths of Prof. Lovén and Prof. Steenstrup. In the section of medicine and surgery Prof. von Leyden has succeeded Prof. Virchow, who has been elected foreign associate of the Academy; and Prof. Mosso has succeeded the late Prof. Tholozan.

THE Council of the Royal Institute of Public Health have awarded the Harben Gold Medal for 1899 to Lord Lister, P.R.S., in recognition of his eminent services to preventive medicine. Prof. William R. Smith, who has been appointed Harben Lecturer for the year 1899, has chosen "Diphtheria" as the subject for his lectures.

A REPORT has reached us from Mr. L. Small, of Denver, of the discovery of a huge fossil Dinosaur that must have been about 130 feet in length. The remains were found by Prof. W. H. Reed, of Wyoming, in Jurassic strata, near Laramie, and indicate an animal much larger than any form that has been previously obtained.

IN addition to the New Year honours referred to last week, Sir Charles Cameron, medical officer of health for the City of Dublin, has had the Order of C.B. conferred upon him.

FATHER RODRIGUEZ DE PRADA has been appointed director of the Vatican Observatory.

THE annual general meeting of the Royal Meteorological Society will be held on Wednesday next, January 18, when the report of the Council will be read, the election of Officers and Council for the ensuing year will take place, and the President (Mr. F. Campbell Bayard) will deliver an address on "The government meteorological organisations in various parts of the world."

ON Tuesday next (January 17), Prof. E. Ray Lankester delivers the first of a course of ten lectures at the Royal Institution on "The Morphology of the Mollusca." On Thursday (January 19), Mr. A. Savage Landor will begin a course of three lectures on "Tibet and the Tibetans." The Friday evening meeetings of the members will commence on January 20, when Prof. Dewar will deliver a discourse on "Liquid Hydrogen."

THE ninth International Congress of Ophthalmology will meet at Utrecht from August 14 to 18. Only the English, French, and German languages will be employed. There will be three sections—one for anatomy, pathological anatomy, and bacteriology; one for optics and physiology; and one for clinical and operative procedures. There will be a secretary for each language as follows: English, Dr. A. McGillivray, Dundee; French, Dr. A. Dufour, Lausanne; German, Dr. A. Siegrist, Bâle.

BY making use of the exceedingly low temperatures that can now be obtained, a very simple method for exhausting X-ray and other vacuum tubes presents itself. An example of this was given by Prof. Dewar at a recent meeting of the Royal Society, at which he was able to produce an almost perfect vacuum. By dipping the end of a closed tube filled with air into liquid hydrogen, the air quickly condensed at the bottom in a solid form. It then only remained to separate from the rest that part of the tube from which the air had been so removed, by heating and sealing off, and the tube was found to possess an extremely high vacuum. In fact, so perfect was the vacuum that it was difficult to pass an electric current through it. One great advantage of this mode of procedure is that in the above case only one minute was taken to obtain the required result.

WE regret to see, in the *Electrical Review*, the announcement of the death of Dr. Eugen F. A. Obach, at the comparatively early age of forty-six years. He was born in Stuttgart, of Swiss parents. In 1875 he obtained his degree of Doctor of Philosophy at the University of Leipzig. After spending a few years in electrical engineering, Dr. Obach devoted himself mainly to the study of the chemistry of gutta-percha and india-rubber, the result of his extensive and varied knowledge of these substances being embodied in his Cantor Lecture delivered before the Society of Arts. A long abstract of these lectures appeared in NATURE in June last (vol. lviii. p. 136). Shortly after that time his health failed, and even prolonged rest from work brought about no improvement, and he died on December 27 at Graz, Styria. Dr. Obach had been a frequent contributor to the literature of electrical science since 1875, about a score of papers being published in the English and German technical journals or in the *Proceedings* of scientific societies.

DR. REINHOLD EHLERT, distinguished by his studies in seismology, has lost his life by an Alpine accident on the Susten Pass. Among other valuable seismological works, he wrote a treatise on "A comparison, explanation, and critical estimate of the most important seismometers, with special reference to their practical utility." This work was *couronné* by the philosophical faculty of the University of Strasburg, where Dr. Ehlert conducted his investigations.

REUTER reports from Copenhagen that Captain Daniel Brunn has decided to organise an expedition next summer to search for traces of Herr Andrée and his companions in the neighbourhood of Eastern Greenland. The expedition will start from the east coast of Iceland, and proceed by way of Jan Mayen Island to the vicinity of Cape Barclay, on the East Greenland coast.

THE *Pharmaceutical Journal* reports the opening of a chemical and pharmaceutical laboratory in Rajkote, the seat of the Government in the province of Kathiawar, Western India. The building is the gift of Azam Laxmon Meram, who contributed 30,000 rupees for its construction; and its equipment has been provided from the State Joint Fund. The object for which the building has been primarily founded is for improving the practice of native medicine and for making known valuable Indian remedies to Western science, and also to ascertain which native herbs may be made more adaptable to science; and it is hoped that eventually it may further the progress of bacteriology and sanitary science. The director of the laboratory is Mr. H. L. Lee.

THE present position of the Rontgen rays in military surgery was described by Major J. Battersby in a paper read before the Röntgen Society on Tuesday. Major Battersby was selected for service in charge of the Rontgen ray apparatus in the Sudan, where the temperature varied from 100 to 122 degrees F. in the shade; and his paper was based upon his experience in this campaign. After the battle at Omdurman 121 British wounded were conveyed to the surgical hospital at Abadieh. Of that number there were 21 cases in which the bullet could not be found, or its absence proved by ordinary methods. In 20 out of these 21 cases an accurate diagnosis was arrived at with the help of the rays, the odd case, who was suffering from a severe bullet wound in the lung, being too ill for examination at the time. The senior medical officer in charge of the hospital said:—"The Röntgen rays proved of invaluable assistance in localising the exact position of bullets, and in many cases rendered probing of wounds unnecessary. . . . In many cases the X-rays prevented much suffering to the patient, which would have been caused by probing, the use of the finger, or enlarging the wound in the ordinary search for the bullets, as the skiagraph at once indicated the exact position of the bullet. In other more complicated cases the Mackenzie-Davidson method localised the exact position of the bullet, so that the surgeon was at once able to come to the conclusion if operative interference was judicious or otherwise. If considered advisable, the removal of the bullet was much facilitated by the diagram previously indicating exactly where the projectile was to be found." With regard to apparatus, the most serious difficulty at present is the best method of generating the primary electrical current for charging the storage batteries, or working the coil direct. Primary batteries, for many reasons, are unsuitable and not to be recommended. In the Sudan a small dynamo, driven by means of a tandem bicycle, answered admirably, and was readily transported by rail and river to Abadieh; but as at present constructed, it is unsuitable for mule, camel, or human transport. An ideal apparatus would consist in a statical or friction machine, some modification, for instance, of Mr. Winshurst's, by which the focus tube could be excited direct. In such a design many physical difficulties will occur, but they are not insurmountable. If it is achieved, it will enable the present apparatus to be reduced very considerably by dispensing with primary and storage batteries, dynamos, bicycles, and induction coils.

WITH reference to the landslip from the Sasso Rosso, which destroyed several buildings at Airolo on December 27, 1898, the Zürich correspondent of the *Times* states that Swiss geologists are of opinion that the landslip is by no means over, and that a mass of rocks equal to that which fell last week has yet to come away. It is hoped that the detachment will take place in smaller masses, and that no slip exceeding the present (400,000 cubic metres in volume) is to be apprehended. The summit of the Sasso Rosso is 2300 metres above the sea level, and 1200 above Airolo, and the falling rocks reached the village with a velocity of 15 to 20 metres per second. The present danger lies in the rocks which remain suspended on the flank of the mountain. Should these give way, the village and the southern exit of the tunnel would be endangered by the avalanche, a risk which is increased by recent heavy rain and snow. Compared with other similar avalanches, the amount of débris already fallen is not excessive; at Elm the fall exceeded 11,000,000 cubic metres, at Goldau it was 25,000,000, and the historic landslip at Brienz in 1749 was estimated at 50,000,000 cubic metres.

THE New York Zoological Society has issued the third number of its *News Bulletin*, in which the progress of the work of transforming South Bronx Park into a Zoological Park is described and illustrated. Seven months ago the New York Zoological Park was a tract of wild land, but since then several of the animal houses have almost been completed, and other enclosures have been made. New York City has voted 30,000 dollars as a maintenance fund for six months, both for the care of the animals and the care of the Park, and is expending 62,000 dollars in the development of roads, walks, drains, and other ground improvements. It is a matter for congratulation that

the Zoological Park appears to have become one of the established institutions of the City of New York. The magnificent site, and the fine buildings and enclosures which will eventually be erected upon it, will give the people of the metropolis of Greater America reason to be proud of their Zoological Park.

DR. ROBERT MUNRO writes to the *Glasgow Herald* with reference to the archæological remains recently discovered in the estuary of the Clyde (see NATURE, vol. lviii. p. 488), and with which his name has been associated. He desires it to be known that he does not endorse the opinions that have been promulgated as to the age, structure, and marvels of the Dumbuck crannog, for he regards it neither as a pile-structure nor as a monument of Neolithic times.

THE curator of the Perak Museum at Taiping reports in the Blue Book on the Straits Settlements (C-9108 of 1898) that the museum is now overcrowded, and that there is consequently much difficulty in arranging the collections in their natural sequence, while there is practically no room for new specimens. The Taiping collections are specially rich in the ethnological and mineralogical branches, and the zoological specimens have recently been greatly improved. The photographic and botanical branches were extended during the year, and the museum now contains a valuable section allotted to economic botany. Investigations were carried out, with satisfactory results, on the subject of insects attacking coffee, rice, and other agricultural products, and some experiments were made in connection with tapping rubber. Discussion has been going on as to constituting the museum at Taiping a central museum, supported by all the Federated Malay States. The curator at Taiping suggests that local museums, of which one has been in existence for several years in Selangor, and which, it is to be hoped, will soon be established in the other States, might either be affiliated to, or form branches of, the Federal museum. On the other hand, the British Resident at Selangor urges that the existence of a local museum creates and sustains in the minds of the community an interest in local products, their sources and uses, which cannot fail to be beneficial and deserving of encouragement, and it cannot be argued that people in Selangor or the Negri Sembilan will obtain any advantage from a museum in Perak, however complete, which few of them will probably ever see.

THE January number of the *Reliquary and Illustrated Archaeologist* contains a note on a paper recently read before the Society of Antiquaries by Mr. P. Norman, on the discovery, at Millfield, Keston, Kent, of a shallow, circular pit containing nearly a thousand chips, flakes, and cores of flint. Mr. Norman drew attention to the fact that a very large proportion of the well-shaped flakes had lost their pointed end, consisting of about one-fourth or one-third part of the entire flake. This had evidently been broken off purposely, and, as none of the points were found among the débris, while many butt-ends remained, it seemed probable that the flakes were produced for the sake of their points. These were broken off and used as arrow-heads, or for some purpose requiring sharp angular points, and thus dispersed about the surface of the surrounding country. A number of cores from which the flakes had been struck, and some large pebbles which had apparently served as hammers for detaching the flakes therefrom, were found lying among the fragments of flint on what must have been the floor of a Neolithic workshop. The hut in which this ancient industry was carried on was about fourteen feet in diameter, and its site was found under an accumulation of earth about two feet thick. Evidence was given that the Millfield pit formed one of the remarkable group of Neolithic hut circles on Hayes Common, some of which had been excavated and described ten years ago by Mr. George Clinch.

To determine the probable meteorological conditions likely to prevail along the path of the total eclipse of the sun, which will occur in the Southern States of America on May 28, 1900, Prof. F. H. Bigelow obtained observations of the state of the sky, and other meteorological conditions along the path of totality, for the period from May 15 to June 15 in the years 1897 and 1898. The results for the former year have already been referred to (vol. lvii. p. 159), and those for the year 1898, containing reports from eighty-seven stations, are given in the latest number of the *Monthly Weather Review* (September 1898). Last year's observations give precisely the same result as was obtained in 1897, namely:—The weather conditions in the interior of Georgia and Alabama were better than in Virginia, North Carolina, South Carolina, Mississippi, and Louisiana; and it would be much safer for the eclipse expeditions to locate their stations in the northern portions of Georgia and Alabama, upon the southern end of the Appalachian Mountains, where the track crosses the elevated areas, than nearer the coast-line in either direction north-eastward towards the Atlantic coast, or south-westward towards the Gulf coast; on the coast itself the weather is more unfavourable than in any other portion of the track.—The inquiry will be repeated during May and June of the present year.

THE reports issued by the Meteorological Office show that, notwithstanding the stormy character of the weather during December, and the almost continual succession of atmospheric disturbances which reached our coasts from the Atlantic during the latter part of the month, the rainfall during that period was only in excess of the average in the north of Scotland, the north of Ireland, and the southern and central parts of England. In the Hebrides, which experienced the full force of many of the storms, the excess was most marked, rain having fallen at Stornoway on every day of the month, on five occasions the fall exceeding an inch, and the total amount measured being little short of 15 inches, or more than 9 inches above the average. There was a considerable deficiency in the east and west of Scotland and the north-east and north-west of England. Reckoning from the beginning of the year, the only marked excess above the average is 16 inches in the north of Scotland. In all other districts, except Ireland, there is a considerable deficiency, the greatest being about 7·6 inches in the south of England.

THE "enclosed" type of alternate-current arc-lamp is much steadier in burning than its predecessors, it is therefore particularly well suited to photographic investigations as to the nature of arcs in general, using rapidly moving photographic plates. Mr. N. H. Brown, in the *Physical Review*, vol. vii. pp. 210–216, 1898, describes his experiments made with an "enclosed" arc. The pictures obtained are not simply broad discontinuous bands of light; they exhibit, as a rule, a symmetrical arrangement of bright patches, in more or less regular alternation, the second patch being "reversed" to the first—like its image seen in a plane mirror. The front end of each patch makes an appreciable angle with the diameter of the plate, representing that the arc starts from one side, and then from the other, successively. The shape of the back ends of the bright patches indicates that the light dies out first near the carbons, and later near the middle of the arc-space. The shape of the back and front ends of the bright patches does not seem to depend upon whether the current curve is or is not a true sine function.

PROF. JAMES S. STEVENS's "Study of various styles of cross-wires," in the *Journal of Applied Microscopy* for October, deals with a subject of such importance in astronomical and other observations, that a short *résumé* of the conclusions may even now be of interest. Four styles of crossed wires were experimented on; in the first, the intersection of two wires

forming an X is brought into coincidence with the given fixed line; in the second, one wire is superposed on the line; in the third, this line bisects the space between two parallel lines; and in the fourth, the reference line is adjusted at one side of the movable parallel lines at a distance from one of them equal to their distance apart. Four observers were selected, each being required to make twelve settings with either arrangement; firstly with time unlimited, secondly with time limited to two or three seconds, and thirdly with each of the four settings taken in alternation. The probable error of the mean of each group of twelve observations was calculated by the Theory of Least Squares. With one exception the method of intersecting wires is found to give by far the largest probable error, and may easily be classed as the poorest method. When the reference mark upon which the wires are to be set is of the same order of magnitude as the movable wire, the method of superposing one upon the other gives the best results. Lastly, when the reference mark is larger, such, for example, as the lines on a graduated scale, the third or fourth method should be used, the choice between these two depending upon the observer. It is thus remarkable that the cross-wire arrangement adopted in the older transit circles should be so inferior to other arrangements.

IN some notes on the geology of Syria (*Bericht der Senckenb. naturf. Gesellsch.*, Frankfurt, 1898), Dr. F. Kinkelin records fossils from the Cretaceous and Eocene formations in a number of localities. It is well known that in Palestine strata from the base of the Upper Cretaceous to the Nummulitic limestones form one great geological group, and it may be judged from the facts made known by Dr. Kinkelin that a corresponding series occurs in northern and central Syria. A new species (*Cardium Dayi*) is described from strata yielding *Inoceramus concentricus* and *Vola* (*Pecten*) *aequicostata*.

REMAINS of fossil Jerboa (*Alactaga saliens fossilis*) have been described, by Dr. A. Nehring, from the Pleistocene strata of Westergeln, between Magdeburg and Halberstadt (*N. Jahrbuch f. Mineralogie, &c.*, 1898, Bd. II.)

THE development of the pattern of the wings of butterflies in the pupa forms the subject of a paper by Countess M. von Linden, in the *Zeitschrift für wissenschaftliche Zoologie*, Band 65, Heft I. The principal species discussed, and illustrated in the three plates which accompany the article, are *Papilio podalirius* and *machaon*, *Thais polyxena*, and *Vanessa levana* and *urticae*. This paper is followed by one upon a similar subject, by Dr. M. Baer, who discusses the structure and coloration of the wing-scales in butterflies. The author recognises three different classes of colour, viz. (1) pure colours, due exclusively to pigment; (2) optical colours, due to refraction; (3) mixed colours, due to the effects of pigment and refraction combined.

THE *Proceedings* of the tenth annual meeting of the Association of Economic Entomologists (U.S. Department of Agriculture, Division of Entomology, *Bulletin* No. 17, New Series) include a variety of short papers on insects of various orders, and the best means of destroying them. Prof. Howard's observations on the ease with which Chalcid parasites of *Coccidae* can be introduced from one country to another, are of considerable importance. There is also a paper by Mr. T. D. A. Cockerell, on "Entomological Ethics," containing some suggestions which may not be unworthy of the attention of those who are responsible for the management of museums and other public collections.

AMONGST the botanical papers read at the last meeting of the American Association for the Advancement of Science is one by Dr. Erwin F. Smith, describing some observations he has made on an organism recently isolated from and believed to be responsible for a disease which appears in sweet corn. It was originally found by Stewart occurring in enormous numbers in the vascular bundles of corn, making the leaves flabby or shrivelled. It is a motile bacillus and is provided with one polar flagellum, and grows in all ordinary culture media, producing a yellow colour both in the latter and in the host plant. It grows best in the presence of cane-sugar, and very striking differences are observed when it is inoculated on to slices of turnips and slices of beetroot respectively, the growth being ten to fifty times as abundant in the case of the latter. In this characteristic may possibly be found an explanation of why sweet corn is attacked in preference to common corn. It has been found in New York and Michigan States, and may be looked for, says its discoverer, in all parts of the United States.

DR. G. AGAMENNONE has contributed to the *Atti dei Lincei* (vii. 11) some interesting statistics relating to the earthquake at Hayti on December 29, 1897. The position of the epicentre was roughly in latitude $19\frac{1}{2}°$ N., longitude 71 W. As mentioned in a former note in NATURE, Dr. Agamennone had previously found considerable difficulty in calculating the velocity of propagation of the Labuan shock, which he attributed to the differences in sensitiveness of the instruments by which it was recorded at various stations. That this explanation was the correct one, is confirmed by analogous observations connected with the Hayti earthquake. Thanks to the existence of a Cecchi seismograph at Port-au-Prince, whose readings could be compared with those taken at Catania and Ischia, the velocity of propagation of different waves was calculated, and was found in no case to reach 10 kilometres per second; and the swiftest waves, probably longitudinal in character, were followed by waves of long period whose superficial velocity seems to have averaged 3 kilometres per second. But it is pointed out that in the absence of the Port-au-Prince Observatory, a comparison of the records made at Toronto and in Europe would have given improbably high values for the velocity of propagation, consequent upon the Toronto instrument being insensible to the first waves which affected the European seismographs.

THE buildings of Oxford, from an engineer's point of view, form the subject of an illustrated article in the January number of the *Engineering Magazine*.

A BRILLIANT heliogravure of Dr. Sidney Coupland, recently appointed Commissioner in Lunacy, appears in the *Middlesex Hospital Journal*. Dr. Coupland has been connected with Middlesex Hospital for many years, in the department of pathological anatomy.

AN instructive description of the great boulder of gypsum, recently found at Great Crosby, is given by Mr. T. Mellard Reade in a pamphlet, a copy of which has been sent to us. A picture of the boulder upon the pedestal erected for it by the District Council of Great Crosby, forms the frontispiece of the pamphlet.

THE new volume of the *Geographical Journal*, containing the six monthly parts from July to December 1898, has been published. Like previous volumes, the present one is filled with interesting papers read before the Royal Geographical Society, articles on topics of geographical importance, a monthly record of contributions to geography in various parts of the world, an invaluable bibliography of current geographical literature, lists of new maps, and numerous coloured maps to illustrate the contents.

A COPY of the second number of the *Zambesi Mission Record* has been sent to us. The periodical is to be published about four times a year, and is concerned with the Catholic missions in

the area under the rule of the British South Africa Company, north and south of the Zambesi. Among the articles in the present number is a very interesting one on some South African beetles, by the Rev. J. O'Neil, S.J., illustrated by photographs of the chief species described. The magazine can be obtained from the Rev. A. M. Daignault, 114 Mount Street, London, W.

THE annual report (new series, vol. ix.) of the Geological Survey of Canada, referring to the operations of the Survey in 1896, has been received. The volume comprises 816 pages. It is accompanied by five maps and illustrated by twenty plates, besides a number of figures in the text. The several parts composing the volume have been issued separately, and most of them have been referred to in these columns. Dr. George M. Dawson's summary report, occupying 144 pages, shows that the Canadian Survey accomplished work of great economic importance in 1896, and added to scientific knowledge by original observations and deductions, and by exploration of new ground in the field.

A SERIES of monthly star maps has been prepared by Mr. Walter B. Blaikie, and issued by the Scottish Provident Institution in a blotting-book. There are two maps for each month, one showing the aspect of the sky in the latitude of London, at 10 p.m., when looking north, and the other the southern aspect. The stars are printed in gold on a blue ground, and the positions of the chief planets visible are indicated. In addition to the maps, which will enable beginners easily to find their way among the constellations, a number of notes on interesting astronomical objects are given by Mr. Blaikie. The idea of issuing maps of this kind from an assurance office is an excellent one, and it has been well carried out.

WE have received the *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften*, Vienna, containing papers presented to the section of mathematics and natural sciences during the period from January 1897 to March 1898. The report is divided into four parts, referring to different branches of science, and each part is published in several divisions. The first part contains papers on natural sciences; the second comprises (*a*) papers on mathematics, astronomy, physics, meteorology, and mechanics, and (*b*) papers on chemistry; and the third part contains papers on anatomical and physiological subjects, excluding purely medical matters. Many of the papers have already been referred to in these columns, and with the others now before us they make a valuable addition to scientific knowledge.

THE question as to the best means of isolating a freezing mixture is one of considerable practical importance in chemical and physical work. In the current number of the *Berichte*, Prof. W. Hempel describes a series of comparative experiments undertaken by him to settle which substance was most suitable for ordinary work. Starting with a temperature of about -75° to -80° C., produced by solid carbon dioxide and ether, the rate of rise of temperature with time was measured, and, as a result, eiderdown was found to be the best insulator, wool carefully dried at 100° C. being nearly as good, and having the advantage of cheapness. Three samples of vacuum tubes, of the pattern invented by Prof. Dewar, were also tried, and were found to give very varying results amongst themselves, and all being much inferior in insulating power to either eiderdown or cotton wool. Thus with eiderdown a rise of 12° C. occurred in eighty-eight minutes, with dry wool a rise of 20° to 24° C. in the same time, whilst the three vacuum-jacketed tubes gave under the same conditions rises of 65°, 69°, and 39° respectively. The results would seem to show that trustworthy Dewar tubes cannot be bought commercially.

THE additions to the Zoological Society's Gardens during the past week include a Huanaco (*Lama huanacos*, ♂) from Punta Arenas, presented by Mr. Henry F. Fox; a Crossbill (*Loxia curvirostris*), European, presented by Mr. H. O. Blanford; two Delalande's Geckos (*Tarentola delalandi*) from West Africa, presented respectively by Mr. Percy Leach and Mr. H. Munt; three Grey Squirrels (*Sciurus cinereus*) from North America, two Dorsal Squirrels (*Sciurus hypopyrrhus*) from Central America, three Nose-crested Iguanas (*Iguana tuberculata rhinolophus*) from Nicaragua, a —— Iguana (*Iguana*, sp. inc.) from Tropical America, deposited; a Leopard, Black variety (*Felis pardus*), from Africa, three Brazilian Caracaras (*Polyborus brasiliensis*) from South America, two Warty-faced Honey-eaters (*Xanthomyza phyrgia*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

COMET CHASE.—This comet, which is a faint object and difficult to observe, has the following ephemeris for the present week:—

Ephemeris for Berlin Midnight.

1899.	R.A. (app.). h. m. s.	Dec. (app.). ° ′
Jan. 13	11 8 48	+30 54·6
15	9 15	31 17·9
17	9 35	31 41·2
19	9 48	32 4·6
21	11 9 55	+32 27·7

Its brightness is now about the same as that at the time of its discovery, and is on the decrease.

ARTIFICIAL MOON MARKINGS.—Mr. S. H. R. Salmon has sent to us a series of slides which are of great interest, since they appear to represent portions of lunar landscapes, and are astonishingly like the real photographs of them. In fact, among all artificial methods of trying to produce lunar effects without the intervention of any hand work this is, as far as we know, the most successful. The process Mr. Salmon employs is very simple and can be easily repeated by any one. It is only necessary to smear a little paste on to a glass slide, and gently warm it from below with a spirit-lamp until it is dry. Observing it then with a microscope, we are confronted with this lunar-like appearance. The slides which we have before us represent many variations of lunar formations. In this one we see a small craterlet on the wall of a large crater, while in another we have rills widening now and again into craterlets. In a third slide we have a large crater, very like some on the moon, showing beautifully the gradation of tone on the surrounding wall. All the markings are, as Mr. Salmon states, perfectly accidental, and can be seen with the microscope. The slides before us are the result of a first attempt at micro-photography on the part of Mr. Salmon, and he is to be congratulated on obtaining such excellent results.

A NEW DOME FOR EQUATORIALS.—The natural evolution in the construction of domes under which equatorials are housed is the elimination of the shutter. Shutters, if they are not perfect, are the causes of so many evils in an observatory, for they may leak, jam, break, and in several other ways do indirectly damage to a valuable instrument. There are several ways in which a dome can be erected and found to work satisfactorily without their presence, and one, set up at Greenwich in 1891 for a transit instrument, has met with marked success. In this case the dome consists of two halves, and as the aperture is required only in the meridian, these are made to roll back one east and the other west. More recently the idea has been extended to the new altazimuth, also at Greenwich; but here the halves are mounted on a ring girder, to allow the aperture to take up any required azimuth. In both these cases the openings had parallel sides.

A later modification for equatorials, due to Messrs. T. Cooke and Sons, of York, is described and illustrated in the current number of the *Observatory* (January), and here the opening is wedge-shaped. The arrangement, as described by the makers, is the following.

"Our object was to do away with the usual shutter covering an opening in the dome. To carry this into effect, the dome is

mounted on a horizontal revolving ring or annular frame, provided with rollers at suitable intervals apart, which roll on a fixed circular track or rail firmly secured to the wall of the building. The dome is made in two halves, divided in a vertical plane through the centre, and hinged at one extremity of this division at two of their adjacent corners to a pin fixed to the revolving ring or annular frame above mentioned. At the opposite corners of the two halves of the dome are fixed rollers, one at each corner, and two other rollers are supplied 90° from the first pair, one in each half. These rollers roll on the surface of the revolving ring, or on short races, in such a manner as to support the two halves of the dome on the horizontal revolving ring, and permit of their being opened or closed. The opening is, of course, a wedge-shaped one. The two halves of the dome being mounted on the ring, which is capable of revolving by means of the rollers resting on the circular rail, the wedge-shaped opening in the dome can be brought to face any part of the sky."

It may be mentioned as a further advantage of this arrangement that in the winter season, when the dome may be covered with snow, it does not prevent it being opened, as is so frequently the case with domes with shutters; and, furthermore, it gives facility for any design of dome being used, which a shutter renders impossible.

A NEW ASTRONOMICAL PERIODICAL.—We have received a circular from the Manora Observatory in Lussenpiccolo, informing us that a new illustrated astronomical periodical will be published from that observatory, with Herr Leo Brenner as editor. Ten numbers will be issued during the year, and these altogether will contain 400 pages and over 100 illustrations. The price for the ten numbers is stated to be twelve shillings, post free.

CONFERENCE OF THE INTERNATIONAL GEODETIC ASSOCIATION.[1]

THE twelfth general conference of the International Geodetic Association was held at Stuttgart on October 3–12, 1898. Fifteen countries of the nineteen composing the Association were represented. Of the thirty-seven delegates present fifteen came from Germany, five from France, three from Italy, two from Switzerland, two from Japan, and one each from Belgium, England, the Netherlands, Austria-Hungary, Russia, Sweden, Spain, Mexico, and the United States. Besides the delegates, eighteen invited guests appeared, making a total of fifty-five persons present at the meetings. By far the greater part of the time was naturally taken up in reading the regular reports by the delegates on the geodetic work accomplished in their respective countries since the last general conference.

Of special interest was the contribution by Prof. Helmert on the activity of the Central Bureau of the Association at Potsdam. The following work was described: (1) The systematic deviations of the plumb line in connection with the European arc on the 52° of north latitude. (2) The international latitude service. (3) Absolute determinations of gravity. The international latitude service will be inaugurated during the summer of 1899 at four stations under the direct control and at the expense of the Association. Observations at two additional stations will be undertaken, for which the Central Bureau will supply only a part of the funds necessary. Although the mathematical conditions are not essentially changed by the introduction of Cincinnati and Tschardjui, there is great advantage from the fact that any systematic errors in the regular stations will be more readily discovered. It is a fortunate coincidence that the observatory at Cincinnati happens to be precisely on the parallel of latitude chosen for this work, and it is, moreover, a matter for congratulation that Russia is ready and willing to aid in the undertaking, to the extent of establishing and superintending the station at Tschardjui.

The latest results from pendulum observations are with reference to changes of the force of gravity with elevation, and the derivation of a new formula for the length (L) of the seconds pendulum at the sea-level. From a discussion of over 500 stations the conclusion is reached that what is usually known as continental attraction amounts practically to nothing, and that in general the change of the force of gravity at any point on the earth's surface depends purely and simply on the Newtonian law of the inverse square of the distance. The introduction of a spherical function of the third order in the formula for L, alluded to before, foreshadows the determination of a different curvature for the northern and southern hemispheres of the earth; yet the coefficient appears so small that the inequality cannot as yet be safely predicted. The compression given is 1/297, and the equatorial value of the force of gravity is about 1 13,000 greater than that now accepted. The investigation of the relation between disturbances in the force of gravity and deviations of the plumb line is one of the most interesting problems of the near future.

Three matters of universal interest were brought before the Association, and suitable action was taken thereon. These were: (1) "The determination of the figure of the earth by the measurement of arcs and the determination of the force of gravity." (2) "The remeasurement of the Peruvian arc." (3) "The redetermination of the difference of longitude between Paris and Greenwich." The first two subjects were introduced as resolutions by the United States delegate, and brought out interesting discussions. The first was proposed for the sake of directing the attention of the Association more specifically to the prime object of its existence. No one doubts the utility or necessity of a complete study of the law governing the changes of latitude, but its ultimate bearing is rather one of astronomy than geodesy. The funds of the Association are now being devoted largely to the latitude question, and the time seemed fitting to suggest work more directly in the line of its avowed purpose—the measurement of the earth. The object of the resolution was, therefore, in the nature of a recall to the original conception of its being, and bespoke in the interest of pure geodesy an application of its resources to a realisation of the idea of its founders.

The remeasurement of the Peruvian arc now appears to be assured. It may be worth while just here to recall the essential features of this work. One hundred and sixty years ago, when it was a disputed question whether the polar or equatorial diameter of the earth was the longer, the French Academy decided to make one supreme effort to settle the point. To this end, two arcs were measured: one on the equator (now known as the Peruvian arc, although it is really in Ecuador); and the other in Lapland, as near the pole as possible. These two arcs, confessedly inaccurate in the light of modern geodesy, have been employed continually in the determination of the earth's figure. Situated as they are, near the extremities of the quadrant, their influence is great on the shape deduced, so that one of the pressing needs of the day in the measurement of the earth is a redetermination of their lengths. It is proposed to make a reconnaissance during the summer of 1899, report the results thereof to the Paris conference of 1900, and then decide definitely on the plans of final measurement. It is universally conceded that France should be given the first chance to act, not alone because the first measure was made by her, but also because the conference of 1889 relinquished in her interest further consideration of the subject.

The Russians and Swedes, in a quiet sort of way, are measuring an arc between the parallels of latitude 77½° and 81½° in Spitsbergen. The triangulation will require two summers and part of one winter, and will cost 100,000 kronen (5500*l.*), exclusive of cost of vessels furnished by the governments. The field work will be finished in 1900, and the computations two years later. Fifty stations will be occupied. The sides range in length from ten to one hundred and thirty kilometres, and the bases, of which there will be only two, are to be measured with Jaederin's steel tape line, twenty metres long.

The difference of longitude between Paris and Greenwich came up again for investigation. Nothing seems to remain but to study the conditions of the work of 1888 and 1892, and reconcile, if possible, the outstanding difference. The matter has been referred by the International Geodetic Association to the directors of the two observatories, and a definite result will, doubtless, soon be made known.

The variation of the latitude seems to be at present an absorbing question before the Association; and there results from action taken at the Stuttgart meeting the following status:—Six stations will be established during the summer of 1899 on the parallel of latitude 39° 8′. These will be distributed in longitude as follows: one each in Japan, Turkestan and Italy, and three in the United States. The American ones will be located at Gaithersburg, Md.; Cincinnati, O.; and Ukiah,

[1] Abridged from an official report by Mr. E. D. Preston to the Superintendent of the Coast and Geodetic Survey, published in *Science*.

Cal. This gives a preponderance of weight to the determination of the coordinate Y (X passing through Greenwich), but a station in Portugal, which may possibly be secured later, would essentially increase the accuracy of X. Tschardjui, in Russia, and Ukiah, in California, are nearly opposite, and Mizusawa, in Japan, is in the only remaining unoccupied quadrant. The scheme proposed is, therefore, a favourable one for the study of the motion of the pole. No one knows as yet how long it will be desirable to continue the observations. The period now provided for is five years, but it is proposed to buy the land upon which the observatories will be located, or lease it for one hundred years. It is evident that at least twenty-one years would be desirable, because during the seven years of observations already made the pole has returned nearly to its mean position, and three of these cycles should be completed before any definite idea can be had as to its mean path. The cost of the entire work will be about 2000*l*. annually. The visual method is to be followed regularly without, however, excluding the possibility of employing later the photographic one, which has already given excellent results. Twelve groups of stars, each comprising eight pairs, will be selected. Six pairs in each group are destined for the latitude determinations proper, while the two remaining pairs, having great zenith distances (about 60°), will, it is hoped, throw light on the question of refraction. The observing period for each night is four hours, and will vary from 7 p.m. to 3 a.m., depending on the situation of the group. The instrumental outfit will consist of a zenith telescope and astronomical clock for each station, except that of Japan. Here a chronometer will be substituted for the clock, on account of the frequency of earthquakes.

Although the object of the general conference was scientific discussion, a faithful historian cannot ignore the social and humanitarian side of the function. From our entrance into the beautiful capital of Wurtemberg until the time of our departure we were the recipients of the most cordial hospitality.

Before closing the present paper, attention should be called to a few points of interest noted during the trip to Stuttgart and return. A flying visit was made to the Royal Observatory at Berlin, the Reichsanstalt at Charlottenburg, and the Geodetic Institute at Potsdam. At Paris the offices of the geographic service and the International Bureau of Weights and Measures were examined, and part of one day was devoted to the English Ordnance Survey at Southampton.

An interesting object at the Berlin Observatory is the instrument with which Kustner discovered the variation of latitude; not alone because of the splendid result achieved, but on account of the conditions under which the work was done. It is mounted on a pier more than twenty feet above ground, on a subsoil of sand, in the middle of a city, with bad atmospheric conditions and about one hundred feet from the public thoroughfares. In spite of these adverse circumstances a new fact was added to science, which had baffled the efforts of larger telescopes under immeasurably better conditions. There is much encouragement in this to investigators with scanty means at their disposal.

At the Aichungs-Kommission a balance was shown which easily determines the weight of a kilogram with an error of 1/200 of a milligram, being 1/200,000,000 part of the quantity sought. They have also a complete series of weights in quartz from 1/2 gram to one kilogram, and thermometers giving the temperature by estimation to 1/1000 of a degree Centigrade.

At Charlottenburg the most striking feature was the extension and perfection of the organisation. Nine buildings in all, of which the two larger are devoted, one to theory and the other to practice, have cost, together with the running expenses since 1887, 3,000,000 marks. The annual outlay is at present about 18,000*l*.

The Geodetic Institute at Potsdam has been much less expensive, and presents many admirable points of arrangement and administration. Among the details may be cited: the clock room, always maintained at a temperature between 20° and 21° Centigrade; the pendulum room, artificially heated on all sides, including the floor; a pillar over fifty feet high, and correspondingly thick, with meridian marks several miles away, to study changes in azimuth and the movement of the earth's crust; and finally a small photographic instrument, by means of which the occupation of a station only requires eight minutes, and gives a determination of the geographical position in latitude within two seconds of arc. The subsoil, as at Berlin, is nothing but sand.

At Sevres, near Paris, several interesting instruments were seen, among which may be especially mentioned that designed for the comparison of the metre with the wave-length of light following Michelson's method, and the apparatus for the determination of coefficients of expansion according to the method of Fizeau. Some recent experiments have been made on a composition containing 36 per cent. nickel and 64 per cent. steel. It appears that the expansion from heat is thus reduced to about 1/50 of what we should expect from the individual components. This discovery will simplify enormously the solution of problems where the temperature question has thus far been the great difficulty. It will, for example, be a comparatively easy matter to make pendulum clocks run with a daily correction of about 1/10 of a second per day under varying temperature conditions.

MIRAGE.[1]

WHEN a ray of light passes from point to point of a medium which is everywhere similarly constituted, its path is a straight line; when it passes from one medium to another medium of different density, then the ray of light is refracted or bent at the surface which separates the two media. When the ray passes from one medium to another which is denser, the refraction or bending is always towards the normal to the surface separating the two media at the point of incidence; when, on the other hand, the ray passes from a medium of a certain density to one of less density, then the bending is always from the normal to the common surface at the point of incidence. The earth is surrounded with a spherical envelope of air, and if that air were always of the same density everywhere its refractive index would be the same, and there would be no terrestrial refraction. But the spherical envelope which surrounds the earth is not all of the same density, and the refractive index of the air varies with the density. There are two causes, in the main, which militate against the uniform density of the atmosphere; one is barometric pressure, and the other is temperature. Taking no account of temperature for the moment, taking merely as the cause barometric pressure, the density of the air diminishes gradually upwards from the surface of the earth, so that the refractive index of the air diminishes upwards. The diminishing of the refractive index is not absolutely proportional to the decrease of density, but it is found by experiment to be sensibly proportional to the excess of the density over unity. The circumstance of normal refraction in the British Isles, as regards temperature, is that there is a gradual diminution of temperature upwards at the rate of about 1/300° F. for every foot of ascent. As the air gets cooler the density increases, so the tendency is to some extent to counteract the effect of barometric pressure, but it does not altogether do so. The result in the normal refraction of the British Isles is that there is a gradual diminution of density upwards.

We may consider the air to be stratified in horizontal layers; as a matter of fact, it is stratified in spherical layers, but it will simplify matters to consider it stratified in horizontal layers, the more so as the sphericity of the earth, though it is a slight cause of terrestrial refraction, is not by any means the chief cause; terrestrial refraction would still exist if the earth had no sphericity, and if its surface were perfectly plane. I show you here a diagram representing the normal state of the atmosphere, and showing the curvilinear path taken by a ray of light when it passes from one point of such an atmosphere to another point horizontally distant from it. The reason a curved path is taken is this: supposing the ray to have a general direction upwards, and supposing it to have been inclined at incidence at a certain angle with the normal, as it is going from a medium—air—to air which is less dense, it bends away from the normal, and therefore there would be a successive bending away from the normal at each layer until finally the ray would arrive at the highest point in the diagram. Then, if it were to pass downwards, it would be passing from a medium of a certain density to one of a greater density, and it would approach the normal at each surface of separation of the media, and therefore its path would be a curved path presenting concavity downwards. A ray of light will actually take some such path, because by curving upwards it takes the path which it can pass over in the least time. Generally, a ray of light takes the minimum path as regards time, and it is found to curve up into the layers of air which are of less density, because it can traverse them with greater velocity. It is important to notice that a ray of light

[1] A lecture, delivered at the Camera Club, by Major P. A. MacMahon, F.R.S.

always presents the concavity towards the denser layers; and there is another principle, that the amount of curvature of the ray, *i.e.* the total bending that there is in the ray over a given length of ray, is directly proportional to the rate at which the density changes along the normal to the direction of the ray. For instance, if we take a vertical line, the normal to the direction of the ray is horizontal, and there is no change of density in that horizontal direction, and accordingly there is no bending of the ray; if, on the other hand, the general direction of the ray is horizontal, the normal to the ray is vertical, and that is the direction along which there is maximum change of density, and therefore in that case you will get maximum bending. We get, then, the two cases: when the ray is vertical there is no bending, no curvature; when the ray is horizontal you get maximum curvature; and for intermediate directions you get intermediate amounts of curvature.

I was first led to look into this subject by considerations which arise in discussing certain questions respecting artillery firing, and I propose to give you some results which I have obtained in order to show the effect of refraction upon artillery fire. A mile on the earth's surface subtends at the centre of the earth an angle of about 52″; the refraction will have a mean angle of about 4″, a minimum value of about $2\frac{1}{2}$″, and a maximum value of about 8″; and taking a range of three miles these values of the refraction would become 12″, about 8″, and about 24″ respectively; and very exceptionally the refraction would amount to about 1′ 18″. The meaning of this, in regard to artillery fire, is that (taking this exceptional amount of refraction), if the tangent sights of the gun were laid upon an object at that distance they would be really laid at an elevation 1′ 18″ too much, and correction for terrestrial refraction would consist in depressing the gun through an angle of 1′ 18″. That is not a very important matter from an artillerist's point of view, because guns can only be laid properly to within about 5′.

There is also the question of determining the range. That can be done from an elevation by an instrument called the depression range-finder. If we take the range of an object by means of this instrument the terrestrial refraction would give a longer range than we ought to have, and the necessary correction would diminish the found range.

I now come to other cases that may present themselves in the density of the air. The case that we have considered already is that of the temperature diminishing gradually upwards at the rate of 1/300° F. for every foot of ascent; in Great Britain the diminution is seldom more than about 1/130° or less than 1/400 F., but in other climates it is different. If the temperature were to fall at a more rapid rate the air would be very much more nearly of uniform density, and that would result in a smaller curvature of the ray. If the fall were at the rate of about 1/30° F. for every foot of ascent it would result in the density of the air being uniform, and there would be no terrestrial refraction at all. A more rapid fall of temperature still would cause a rise of air density upwards, and that would cause a curved ray with the concavity presented upwards. In such a case the refraction is said to be negative, whereas in the case that we had formerly the refraction is said to be positive. On the other hand, a rise of temperature upwards causes a rapid diminution in air density in ascending, and the ray with the concavity presented downwards is then more curved; and in the extreme case in which the rise of temperature upwards is at the rate of 1/16 F. for every foot, the curvature of the ray would be the same as that of the earth, and in that case—which, of course, would never actually present itself—we should be able to see completely round the globe, simply because the ray would encircle it. Again, climatic conditions may lead to another distribution of the density. There might be a gradual rise in density upwards to a certain stratum of maximum density, and then a diminution of density upwards, in which case the ray of light would pass in a curious sinuous path with the concavities presented towards the denser layers.

[Major MacMahon here enumerated conclusions, relating to terrestrial refraction in the plains of India, drawn from the experiments and observations of the late General J. T. Walker, R.E., formerly Superintendent of the Great Trigonometrical Survey of India, from which it appeared that the circumstances mainly affecting terrestrial refraction were in order of importance as follows: (1) The time of the day, (2) the temperature, (3) the aspect of the sky—whether cloudy or sunshine, and (4) the humidity of the air.]

Before proceeding to the next part of my subject, I will mention the well-known case of astronomical refraction—the circumstance that during a total eclipse of the moon the whole disc of the moon is not obscured, the fact being that the rays of the sun in passing through the atmosphere of the earth are refracted towards the normal, and in that way some light does get upon the surface of the moon.

I come now to that effect of extraordinary refraction which is more especially termed mirage, and which was first noticed, so far as we know, by the French army under Napoleon. The conditions favourable to mirage are generally a very hot sun and a sandy soil, which becomes very hot under the influence of the sun, and an almost total absence of wind. Under these circumstances there is an extraordinary amount of negative refraction, the rays are very much curved, and the concavity is presented upwards. An illustration which is familiar to everybody, because it occurs in many books on physics, is that in which the observer sees the top of a tree by means of a negatively-curved ray, and it accordingly appears to him to be in the direction of the tangent to the ray where it enters the eye; the other points in the tree he sees in other directions, and altogether the tree appears with an inverted image below it. Not only so, but where there is a very clear sky that also is refracted down, so that the tree appears in the midst of an inverted image of the sky, which has very much the appearance of water. This phenomenon is very common in Egypt. In Egypt there is very often a great quantity of sand with villages dotted about, these being somewhat raised in order to escape the periodical inundations of the Nile, and the effect to an observer is that of a number of raised villages in the midst of what appears to be an enormous lake. The illusion is increased by two circumstances: first, that by reason of the great heat of the sand there is a considerable convection of heated air upwards, which gives the air that peculiar rippling appearance, causing the refracted sky to look like ruffled water; and second, that the general direction of the ray is very similar to that of a ray reflected by a horizontal mirror placed upon the ground. This phenomenon is also common in Australia and in the plains of India, in the low-lying fen districts of England, and on the shingle ranges at Lydd.

One very curious thing about mirage is that it depends very much upon the position of the eye; a few inches in the height of the eye may make all the difference. I remember myself, on the plains of India, observing a mirage which was only evident when I was at a particular height; there was only a vertical space of two or three inches in which the effect could be seen, so that these phenomena may easily escape notice. A singular effect may sometimes be observed at a particular spot on the south coast, and very likely at other places; when the waves come in on to a very hot beach, if you place the eye within about a foot from the ground and look parallel to the wave-fronts, you can see an image of the wave two or three feet above the real wave. This may conceivably arise in this way: the wave may bring in some cold air, and if the wind were blowing a little off the heated beach there might be some heated air brought in as a layer above that cold air; that would give that rapidly diminishing density upwards which gives a ray with considerable curvature and with concavity presented downwards, and would certainly result in an image of the wave above the real wave.

I should like to mention a case of refraction observed on the artillery ranges at Lydd, which has given rise to some controversy. An officer was firing on a hot sultry day, from an ordinary Maxim machine gun at a target about 600 yards distant, and as the firing went on he saw a great wedge-shaped gap in the top of the target, and he thought that the hail of bullets had beaten down a part of the target. To his astonishment, however, when the firing ceased the gap disappeared, and the target appeared intact and undamaged. I imagine this to be an effect of mirage. I conclude that he was looking over the gun through the heated gases rising from the muzzle, which formed a medium of gradually increasing density upwards; he was observing the upper portion of the target through this medium, and I have no doubt that that caused negative refraction, bending the rays so that the sky above the target was seen in the shape of a wedge, something like the shape of the vertical section of the rising gases. I have discussed the matter with physicists, and some agree with me, but other physicists of note do not accept the explanation which I have given.

I now pass on to another part of the subject, which is called "looming." Distant objects are said to "loom" when they

appear in positions much higher than their actual positions, that is to say, when images of them appear considerably raised above their true positions. The effects of looming are very extraordinary, and I have some slides to show you which I have prepared from examples recorded by Commander William Scoresby, who went on his third voyage in his ship the *Baffin* to the Greenland whale fishery in the spring of 1822. The first of these views includes several large irregularly-shaped icebergs, which must cause very unusual distributions of air density, and gave rise to quite remarkable vertical and lateral refractions. In the second there are images of ice which was quite out of sight or quite beyond the horizon. There was extraordinary vertical magnification; small hummocks of ice were drawn out into spires, sometimes of a castellated shape and sometimes having the appearance of naked trees; at other times there appeared to be a city of ice, with public edifices, spires, &c., and Commander Scoresby states in his book that these effects were constantly changing, and were never the same for two minntes together. The first of these drawings, which you saw on the screen, showed a curious inverted image of a ship in the sky, raised considerably above the horizon; that ship was so distant that it could not be seen with a powerful telescope.

During the Crimean War observers on one occasion saw the whole of the British Fleet inverted at a considerable height, an illustration of which appeared in *The Illustrated London News* at the time. Some very interesting cases were recorded by Dr. Vince in the Bakerian lecture of 1798, read before the Royal Society, some of which are delineated in the succeeding slides. He remarks upon these curious phenomena that he thinks that in cases of national emergency certain people should be told off with telescopes to look out for the enemy's ships, and to search the horizon to see if they could detect any ships looming. Dr. Vince mentions another remarkable instance in which he saw Dover Castle from Ramsgate, at a point from which the whole of the keep of the castle cannot be seen, the four turrets only being visible. The most curious case of lateral refraction that I have been able to discover was observed at Geneva in 1818, by M. Jurine; a barque was seen approaching on the left bank of the lake, and at the same time an image of the sails was observed above the water, which, instead of following the direction of the barque, separated from it and appeared to approach Geneva by the right bank of the lake, the image moving from east to west while the barque moved from north to south. This case was brought to the notice of Biot, the physicist, and he, in one of the scientific journals, gave a very long explanation. He came to the conclusion, from the geographical features, and climatology, and the direction in which the sun's rays were passing at the time of the observation, that there would be considerable lateral difference in the temperature, quite sufficient to produce this phenomenon of lateral refraction.

Another case of curious refraction has been noticed by many people—I have seen it myself particularly on the coast of Norway. Low lands, and the extremity of headlands, or points forming an acute angle with the horizon of the sea, and viewed from a distance beyond it, appear elevated above it, with an open space between the land and sea, the effect being proportional to the amount of evaporation taking place at the surface.

Fata Morgana is a name given to an optical phenomenon sometimes seen in the Straits of Messina between Sicily and the Italian coast. Minasi says: "When the rising sun shines from that point whence its incident ray forms an angle of about 45° on the sea of Reggio, and the bright surface of the water is not disturbed either by wind or current, the spectator being placed on an eminence of the city with his back to the sun and his face to the sea, on a sudden there appear in the water various multiplied objects, namely, numberless series of pilasters, arches, castles, columns, towers, palaces with balconies and windows, valleys of trees, plains with herds and flocks, &c., in their natural colours and proper action, passing rapidly in succession along the surface so long as the above-mentioned causes exist. If, in addition, the atmosphere be highly impregnated with vapour and dense exhalations not previously dispersed by the action of the wind and waves, or rarefied by the sun—in this vapour, as in a curtain, to a height of 24 or 25 feet, and nearly down to the sea, the observer sees the same objects not only reflected from the sea, but likewise in the air, though less distinct. Lastly, if the air be hazy and slightly opaque and dewy, the objects appear only at the sea surface, but with prismatic colours." He endeavours to prove that they are representations of objects on the two coasts. He considers the sea an inclined speculum, on account of the rapid current which runs through the Straits, and divided into different planes by contrary eddies, and he ascribes the *aerial morgana* to the refractive and reflective power of matter suspended in the air.

Lastly, I would mention the experiments of Wollaston upon the subject of refraction and mirage. First, he says, into a square phial containing a little clear syrup put an equal quantity of water in such a way that it floats without mixing, and after a little time, by mutual penetration, you see effects; if you view through the syrup a card with a written word upon it, you see it, and also above it an inverted and erect image of the same. That is a case in which the density diminishes upwards, and the ray has its concavity presented downwards. Then, above the water he placed rectified spirits of wine, when the inverted and erect images were seen below, these appearances continuing many hours and even days, and he carried out similar experiments with water at different temperatures. Everybody knows the experiment with a red-hot poker; the effects of mirage can be seen by looking along the surface of a red-hot poker, held at a distance of about a foot from a sheet of paper, when there is perceptible refraction. Again, Wollaston looked along a horizontal plate of glass upon which he poured ether, and a line appeared instantaneously upon the opposite wall at an elevation of half a degree, this effect being due to the cold caused by the evaporation of the volatile liquid. Finally, Brewster showed that all the phenomena of unusual refraction might be observed by holding a heated iron over a mass of water bounded by parallel plates of glass, and then substituting a cold bod y for the hot iron.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE foundation-stone of the Gordon Memorial College at Khartum was laid on Thursday last by Lord Cromer, who remarked that the College would aim at diffusing knowledge of agriculture, engineering, and other practical acquirements useful to all classes.

THE New South Wales Government invite applications for the position of Professor of Physics in the University of Sydney, from University graduates under thirty-five years of age. Particulars of the conditions of appointment, duties, &c., can be obtained from Sir Daniel Cooper, Bart., G.C.M.G., Acting Agent-General for New South Wales, 9, Victoria Street, Westminster, London, S.W.

THE necessity of encouraging scientific investigation, and of providing means for training investigators, is pointed out by Prof. Cleveland Abbe in the U.S. *Monthly Weather Review* (September 1898). He remarks:—A mistaken idea has widely prevailed that the investigator is a genius, born and not made. The history of German science has, however, shown that environment and training are as important as birth and inheritance. The whole system of education in the German universities has for five generations been directed to the development of the investigator as its highest product. Those who discover important new facts, laws, or principles have been rewarded with the highest places in the intellectual world of that nation. Those who feel that they have a desire or calling for scientific research are encouraged to study for the degree of doctor of philosophy, a degree that is only granted when the candidate has, by actual observation, experiment, or exploration, made some important contribution to human knowledge. The professors under whom he studies have, in their turn, made many similar contributions, and are well prepared to judge of the value of *his* work. The German universities have, during the past seventy years, published over fifty-thousand so-called "doctors' dissertations," embodying the results of the works of fifty thousand candidates. The consequence is that to-day Germany easily leads all the world in the amount and value of her contributions to human knowledge and the energy with which her students pursue the study of nature.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, December 1898.—At the October meeting of the Society seven papers were communicated. Abstracts of the papers not to be published in the *Bulletin* are given.—Prof. Woodward's paper, on

the mutual gravitational attraction of two bodies whose mass distributions are symmetrical with respect to the same axis, deals with certain problems in the theory of Attraction which, although fairly accessible to treatment, seem to have been overlooked (some of the equations occur in Todhunter, "History of the Theories of Attraction and Figure of the Earth," vol. ii. p. 102).—A paper by Prof. Roe, on symmetric functions, considers the matter from two standpoints. The first part deals with the functions as a whole, and is mainly critical and historical. Part ii. treats of the individual terms of a symmetric function, together with their coefficients. Prof. Chessin applies the theory (which we have noted in the abstract of a paper previously read by him) to the problem of three bodies m_1, m_2, m_3, viz. when the mass of one of them (m_3) is infinitely small compared with the masses m_1 and m_2, while the eccentricity of the orbits of m_1 and m_2 is zero, so that these bodies move uniformly in concentric circles above their common centre of gravity. Such is very nearly the case of a small planet in the presence of the sun and Jupiter, and also very approximately the case of satellites.—Prof. Lovett's contact transformations of developable surfaces discusses the determination of the contact transformations which leave invariant the partial differential equation $| p_{11}, p_{22}, \ldots, p_{nn} | = 0$ (*cf.* Lie, Darboux and Mayer. Some of the results are complete generalisations of those of a memoir of G. Vivanti, *Rend. di Circ. Mat. di Palermo*, vol. v. 1891).—Concerning a linear homogeneous group in $C_{m,q}$ variables isomorphic to the general linear homogeneous group in m variables, is a paper which was read by Dr. L. E. Dickson at the August meeting. It is chiefly concerned with continuous groups, but its results are readily utilised for discontinuous groups. An analogous isomorphism is discussed in a paper presented recently to the London Mathematical Society.—A second locus connected with a system of coaxial circles, by Prof. T. F. Holgate, read at the same meeting, is a very interesting extension of a paper, by the same author, which was communicated to the Toronto meeting, November 1897.—Prof. Emch, of Biel, Switzerland, communicates a note, entitled "Reciprocal transformations of projective coordinates and the theorems of Ceva and Menelaos." The note is illustrated with diagrams. The author confines himself to the two above-named theorems and their connection with certain transformations of plane and space. The properties admit of multiplication, some of which have been discussed by Rosace and Steiner.—The "notes," as usual, contain a good deal of information useful to mathematical students.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 15, 1898.—"Note on the Densities of 'Atmospheric Nitrogen,' Pure Nitrogen, and Argon." By William Ramsay, F.R.S.

It is concluded that the density of "atmospheric" nitrogen is correctly given as the mean of the densities of the constituents, taken in the proportion in which they occur.

Chemical Society, Dec. 15, 1898.—Prof. Dewar, President, in the chair. The following papers were read.—The interaction of ethylic sodiomalonate and mesityl oxide, by A. W. Crossley. Mesityl oxide and ethylic sodiomalonate do not condense in the expected manner, but the product on hydrolysis yields a diabasic acid, $C_{16}H_{24}O_4$ melting at 148–148·5; derivatives of this acid are described.—The interaction of ethylic malonate and acetylene tetrabromide in presence of sodium ethoxide, by A. W. Crossley. Ethylic disodiomalonate and acetylene tetrabromide react with evolution of acetylene and formation of tribromethylene and tetrethylic acetylenetetracarboxylate.—Derivatives of camphoric acid: Part iii., by F. S. Kipping. A number of compounds obtained from π-bromocamphoric acid are described.—Synthesis of αββ-trimethylglutaric acid, by W. H. Perkin, jun., and J. F. Thorpe. Ethylic sodio-α-cyano-ββ-dimethylglutarate is obtained by the interaction of ethylic cyanacetate, ethylic dimethylacrylate and sodium ethoxide; methylic iodide converts it into ethylic α-cyano-αββ-trimethylglutarate which on hydrolysis gives αββ-trimethylglutarimide. This imide yields αββ-trimethylglutaric acid, $COOH.CHMe.CMe_2.CH_2.COOH$, when heated with hydrochloric acid.—Hydrolysis of methylic and ethylic γ-cyanoacetoacetates and their derivatives, Part i., by W. F. Lawrence. Methylic γ-cyanodimethylacetoacetate is hydrolysed by hydrochloric acid with formation of αα-dimethyl-β-hydroxyglutaconic acid, $COOH.CH:C(OH).CMe_2.COOH$; this, on reduction with hydriodic acid, yields αα-dimethylglutaconic acid.

Geological Society, December 21, 1898.—W. Whitaker, F.R.S., President, in the chair.—On a Megalosauroid jaw from Rhætic beds near Bridgend, Glamorganshire, by E. T. Newton, F.R.S. The specimen which forms the subject of this communication was obtained by Mr. John David of Porthcawl, and it has been presented to the Museum of Practical Geology. It was derived from beds low down in the Rhætic series, which may eventually have to be included in the upper part of the Keuper. The specimen does not admit of exact comparison with *Megalosaurus*, and it is named as a new species of *Zanclodon*—a genus in which the author is also inclined to place some forms described under the names of *Palaeosaurus*, *Cladyodon*, *Avalonia*, and *Picrodon*.—The torsion-structure of the Dolomites, by Maria M. Ogilvie [Mrs. Gordon]. The paper opens with a general account of the work of Richthofen, Mojsisovics, Rothpletz, Salomon, Brögger, the author, and others on the Dolomitic area of Southern Tyrol. It then gives the results of a detailed survey recently made by the author of the complicated stratigraphy of the rocks of the Groden Pass, the Buchenstein Valley, and the massives of Sella and Sett Sass; together with the author's interpretation of these results, and her application of that interpretation to the explanation of the Dolomite region in general. The author concludes that overthrusts and faults of all types are far more common in the Dolomites than has hitherto been supposed. The arrangement of these faults is typically a *torsion*-phenomenon, the result of the superposition of a later upon an earlier strike. This later crust-movement was of Middle Tertiary age, and one with the movement which gave origin to the well-known Judicarian-Asta phenomena. The youngest dykes (and also the granite-masses) are of Middle Tertiary age, while the geographical position of both is the natural effect of the crust-torsion itself. This crust-torsion also fully explains the peculiar stratigraphical phenomena in the Dolomite region, such as the present isolation of the mountain-massives of dolomitic rock. After discussing in detail the structure of various areas, the author applies her results to the interpretation of the complexities of the Judicarian-Asta region of the Dolomites in general, and also to the explanation of the characteristic structural forms of the Alpine system as a whole.

Royal Microscopical Society, December 21, 1898.—Mr. E. M. Nelson, President, in the chair.—The President exhibited a new objective by Carl Zeiss, called a "Plankton-searcher," a low power water immersion objective, designed for use in examining living objects in water, the definition of which was exceedingly sharp. He also exhibited an erecting eye-piece fitted with Porro's prisms, another new appliance produced by the same firm, which would be found useful for dissecting and other purposes.—Mr. Keith Lucas exhibited and described a new model microscope, the design of which was to effect the coarse and fine adjustments by means of a single slide, thereby reducing the expensive work of planing.—The President directed attention to some of the various types of binocular microscopes that were exhibited: among those referred to were Ahrens' binocular eye-piece, in which both tubes were equally inclined, and a microscope by Murray and Heath, one tube only being inclined, the other lying in the optical axis of the instrument, the construction being similar to that of Nachet; these two instruments were exhibited by the Society.—There was a new binocular dissecting microscope by Leitz, exhibited by Messrs. Watson and Sons, consisting of two Brucke lenses fitted on a bar by jointed attachments so that the distance between the tubes could be adjusted to suit the eyes. This was likely to prove valuable for examination of objects, or for dissection under low power.—Attention was directed also to a form exhibited by Carl Zeiss, made with Porro's prisms, giving an erect image; this microscope is provided with two objectives of equal power, one for each tube, the stereoscopic effect being greater than that obtained by a divided image from one objective.—Messrs. Powell and Lealand exhibited their high-power binocular prism in conjunction with a 1/20-inch apochromatic objective.—A Mojinie's portable binocular, a Nelson model, Wenham's binocular with a high power objective, a binocular microspectroscope, were exhibited, besides various patterns of Stephenson and Wenham binocular microscopes by Messrs. Chas. Baker, R. and J. Beck,

J. Fillischer, Swift and Son, and Watson and Sons.—Among the other objects exhibited may be mentioned typical species of Foraminifera selected from various localities by Mr. A. Earland, which were rare and beautiful; and mounted specimens of Hydrozoa, by Mr. G. E. Harris.

EDINBURGH.

Royal Society, December 19.—Lord Kelvin in the chair.—Mr. R. G. Alford read a paper on crane scaffoldings, their mathematical calculations and probable theoretical deficiencies. The paper was a comparison of two similar scaffoldings, one of which was overturned in a gale which the other resisted.—In a note on dew bows, Drs. Knott and Lundie gave an account of a system of brilliant "bows" produced at night on the ground, the source of light being the gas-lamp or electric light of the street. The phenomenon required the existence on the ground of a layer of numerous globules of water of nearly the same size and so small as to suffer little distortion from perfect sphericity. The globules were fog particles, which had gradually settled down in the still air of the last of four days of heavy fog. The curves formed by these dew bows are plane sections of a toroidal surface. Some of the curves were drawn on a black board by means of a simple but obvious kinematical model.—Lord Kelvin communicated a paper on the reflection and refraction of solitary plane waves at a plane interface between two isotropic elastic mediums, fluid, solid, or ether. The investigation presented certain novelties of treatment. One of these was the introduction of the condensational-rarefactional waves of reflection and refraction moving with slow velocities through the (contractile) ethers. (The *four* waves into which a wave of either type breaks up at the boundary of two elastic solids were first discussed by Knott in 1888, with special reference to earthquake waves.) Then there was the question of the total reflection of a solitary wave instead of a train of waves. And finally there was the application of the principle of the continuity of the rotational magnetic force at the interface. Fresnel's *sine* and *tangent* formulæ for the reflection of plane polarised rays followed at once.—Mr. Sydney A. Kay communicated a paper on the equilibrium between sulphuric acids and sulphates in aqueous solutions. The concentrations of the free acid, neutral sulphate, and acid sulphate in solutions containing sulphuric acid and a neutral sulphate were determined by means of a reaction velocity method—namely, by the catalysis of ethylic acetate. Then the degrees of dissociation in the three substances were calculated from Kohlrausch's later determinations of the electric conductivities at infinite dilution. Finally an expression for the equilibrium was developed as an empirical formula which, within the limits of the experiments, gave results in close agreement with observation. The formula was

$$\frac{\{\text{Conc. } H_2SO_4(1-\alpha_1)\}^{0\cdot 85}}{\text{Conc. } MHSO_4(1-\alpha_3)} = \frac{A}{\{\text{Conc. } M_2SO_4(1-\alpha_2)\}^x}$$

where conc. means concentration, M is the symbol for the metal involved, α_1 α_2 α_3 are the degrees of dissociation, A and x are constants with characteristic values for each case. Thus, when M is potassium, sodium or lithium, A has corresponding values 0·259, 0·0618, or 0·0600 respectively, and x has values 1, 1·35, 1·35 respectively.—Mr. David Robertson read a paper on dust figures of electrostatic lines of force. These were obtained by sprinkling the dust over a glass plate against the under surface of which were pressed electrodes in connection with a Wimshurst machine. The chief difficulty was to get a suitable substance; for the particles should be sufficiently conducting to be acted on inductively, and yet sufficiently insulating to prevent escape of the charges. Of the many kinds of dust tried, pure mahogany sawdust coloured with ink was found to be the most efficient. It was stated that the secret of getting good results lay in stopping the action of the machine at the right moment. Many interesting examples of the curves were exhibited.—In a note on the action of persulpates on iodine, Dr. Hugh Marshall drew attention to a reaction which seems to have been neglected by recent experimenters. When, for example, a solution of potassium iodide is being boiled with ammonium persulphate so as to decompose it and drive off the iodine by sublimation, the iodine in the liquid seems to disappear at a more rapid rate than corresponds to the amount volatilised. In fact, as was proved by direct experiment, the iodine is oxidised by the persulphate, and becomes iodic acid.—A paper by Prof. Anglin, on the summation of the series whose nth terms are u_n and $1/u_n$ where u_n denotes

$$(an+b)\{a(n+1)+b\}\{a(n+2)+b\}\ldots\{a(n+r-1)+b\}$$

was also read.

PARIS.

Academy of Sciences, January 2.—M. van Tieghem in the chair.—On the estimation of phosphorus and sulphur in plants and their ashes, by M. Berthelot. Of the various methods suggested for determining sulphur and phosphorus in plants, burning in a stream of oxygen, and subsequently passing the gases over a long column of red-hot sodium carbonate, gave the highest results. Prolonged boiling with strong nitric acid or estimation after incineration showed large deficiencies in both sulphur and phosphorus.—On the presence and estimation of chlorine in plants, by M. Berthelot. Combustion with oxygen in presence of sodium carbonate gave higher results than a careful incineration in the ordinary way. An attempt was made to distinguish between the total chlorine and the chlorine existing in the plant in the form of chlorides, but without much success.—Preparation and properties of an organic ammonium, lithium—monomethylammonium, by M. Henri Moissan. Anhydrous methylamine reacts vigorously with lithium at temperatures near 0° C., forming a blue solution similar to the alkaline ammoniums. The composition approximated to Li $(CH_3.NH_2)$. In a vacuum this loses methylamine, and finally deposits brilliant crystals of metallic lithium, no gas being evolved.—Influences of metallic armatures upon the properties of mortars, by M. Considère.—Constitution of the ring of small planets, by M. Jean Mascart. Curves are given showing the distribution of longitudes of the nodes and perihelia of the asteroids for every 30°.—Observation of the total eclipse of the moon of December 27, 1898, made at the Observatory of Lyons, by M. Ch. André. The state of the sky interfered considerably with the observations.—Observations made at the Observatory of Toulouse during the eclipse of December 27, 1898, by MM. Baillaud, Bourget, Montangerand, Rossard, and Besson, by M. Baillaud. Ten photographs were successfully taken during the eclipse —Observations of the Brooks comet (October 1898) and Chase comet, made at the Observatory of Toulouse with the Brunner equatorial, by M. F Rossard. — On the propagation of liquid waves through water, by M. Georges Poisson.—On the absorption of light by a body placed in a magnetic field, by M Auguste Righi. When such gases as nitrogen peroxide, iodine, iodine monobromide, iodine monochloride, or selenium tetrabromide of suitable concentration are placed in the path of a ray of light in a strong magnetic field, a distinct change in the colour of the transmitted light is noticeable when the electromagnetic circuit is completed.—On a simple form of magnetometer, by M. A. Guillet. Two diagrams of the apparatus are given, together with the theory of the instrument, but no actual measurements are cited.—General method of separation of chlorine, bromine and iodine in the form of silver salts, by M. H. Baubigny. The dry silver salts are treated with sulphuric acid containing bichromate, the chlorine and bromine distilled off into potash containing sulphite, and these separated by the use of potassium permanganate and copper sulphate. The two test analyses given are very satisfactory.—On the formation of the head of the Hymenoptera, by M. L. G. Seurat. The head is formed uniquely from the head of the larva; at first invaginated, this head, by a movement of rotation in the median plane, becomes devaginated and acquires its final form.—A transverse section of the Briançon Alps, from Gironde to the Italian frontier, by MM. Kilian and Lugeon.—Ostioles in the animal and vegetable kingdoms considered as a regulating apparatus, by M. J. J. Andler.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 12.

MATHEMATICAL SOCIETY, at 8.—On a Determinant each of whose Elements is the product of k Factors: Prof. W. H. Metzler.—Properties of Hyper-space, in relation to Systems of Forces, the Kinematics of Rigid Bodies, and Clifford's Parallels: A. N. Whitehead.—A Simple Method of Factorising Large Composite Numbers of any unknown form: D. Biddle.—Zeroes of the Bessel Functions (second paper): H. M. Macdonald.—Linear Substitutions and Inversions: Dr. G. G. Morrice.—On the Reduction of a Linear Substitution to its Canonical Form: Prof. Burnside, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

FRIDAY, JANUARY 13.

ROYAL ASTRONOMICAL SOCIETY, at 8.—A Suggestion for the Explanation of Stationary Radiant Points of Meteors: Prof. H. H. Turner.—Remarks on Prof. Turner's Paper, with another Suggested Explanation of Stationary Radiant Points of Meteors: Prof. A. S. Herschel.—Observations of the Leonids, November 1898: Observatory, Perth, West Australia.—On the Value of Possible Observations from Free Balloons: Rev. J. M. Bacon.—Note on Dr. Gill's paper "On a New Instrument for Measuring Astrophotographic Plates: Prof. H. H. Turner.—Note on Mr. Espin's Object in *Perseus*: C. D. Perrine.—Eclipse of the Moon, December 27, 1898: Rev. W. Sidgreaves.—The Great Sun-spot of September 1898: W. H. Robinson.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Application of the Science of Mechanics to Engineering Practice: Dr. Archibald Barr.

MALACOLOGICAL SOCIETY, at 8.—Notes on the Anatomy of some Snails (*Trachycystis, Dorcasia* and *Isomeria*): W. Moss and W. Mark Webb.—Illustrations of, with Notes on, some Non-Marine Hawaiian Molluscs: E. R. Sykes.—Description of New Non-Marine Molluscs from the Hawaiian Islands: C. F. Ancey.—Note on *Voluta Roadknightae*: Agnes Kenyon.

MONDAY, JANUARY 16.

SOCIETY OF ARTS, at 8.—Bacterial Purification of Sewage: Dr Samuel Rideal.

IMPERIAL INSTITUTE, at 8.30.—Personal Experiences in China: Rev. Gilbert Reid.

VICTORIA INSTITUTE, at 4.30.—Glacial Action in the Southern Hemisphere.

TUESDAY, JANUARY 17.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R S.

ZOOLOGICAL SOCIETY, at 8.30.—General Account of his Zoological Expedition to the South Seas: Dr. Arthur Willey.—On the Characteristic Points in the Cranial Osteology of the Parrots: Prof. D'Arcy W. Thompson, C.B.—Report on the Gorgonacean Corals collected by Mr. J. Stanley Gardiner at Funafuti: Miss Isa L. Hiles.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Effects of Wear upon Steel Rails: William G. Kirkaldy.—On the Microphotography of Steel Rails: Sir William C. Roberts-Austen, K.C.B., F.R.S.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—On some New Half-tone Screens of English Manufacture: J. E. Johnson.

ROYAL STATISTICAL SOCIETY, at 5.

WEDNESDAY, JANUARY 18.

SOCIETY OF ARTS, at 8.—Canals and Inland Navigation in the United Kingdom: L. F. Vernon Harcourt.

GEOLOGICAL SOCIETY, at 8.—Felsitic Lavas and Tuffs near Conway (North Wales): Frank Rutley.—The Geology of Southern Morocco and the Atlas Mountains: the late J. Thomson.

ROYAL METEOROLOGICAL SOCIETY, at 7.45.—Annual General Meeting.—Address by the President (Mr. F. C. Bayard), on the Government Meteorological Organisations in various parts of the World.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Annual Presidential Address.

ENTOMOLOGICAL SOCIETY, at 8.—Annual Meeting.—Address by the President, Mr. Roland Trimen, F.R.S.

THURSDAY, JANUARY 19.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Observations upon the Normal and Pathological Histology and Bacteriology of the Oyster: Prof. Herdman, F.R S., and Prof. R. Boyce.—On the Formation of Multiple Images in the Normal Eye: S. Bidwell, F.R.S.—On the Vibrations in the Field round a Theoretical Hertzian Oscillator; Prof. K. Pearson, F.R.S., and Miss Lee.—On the Refractive Indices and Densities of Normal and Semi-normal Aqueous Solutions of Hydrogen Chloride, and the Chlorides of the Alkalies: Sir J. Conroy, F.R.S.

ROYAL INSTITUTION, at 3.—Tibet and the Tibetans: A. H. Savage Landor

SOCIETY OF ARTS (Indian Section), at 4.30.—Railways in Burma, and their proposed Extension across Yunnan: J. Nisbet.

LINNEAN SOCIETY, at 8.—New Peridiniaceæ from the Atlantic: G. R. Murray, F.R.S., and Miss F. G. Whitting.—On the Structure of Lepidostrobus: Arthur J. Maslen.—Some Observations on the Caudal Diplospondyly of Sharks: Dr. W. G. Ridewood.

CHEMICAL SOCIETY, at 8.—Researches on Moorland Waters. I. Acidity: W. Ackroyd.—a-ketotetrahydronaphthalene: Prof. F. S. Kipping, F.R.S., and Alfred Hill.—A New Method for preparing *as*-dimethyl- and Trimethyl-succinic Acids: William A. Bone.—Reduction of Optically-active Mono- and Di-alkyloxysuccinic Acids from Malic and Tartaric Acids: Prof. Thomas Purdie, F.R.S., and William Pitheathly.—Action of Ammonia on Ethereal Salts of Organic Bases: Dr. Siegfried Ruhemann.—Esterification Constant of Substituted Acetic Acids: Dr. J. J. Sudborough and Lorenzo L. Lloyd.—Di-ortho-substituted Benzoic Acids. Part IV. Formation of Salts from Di-ortho-substituted Benzoic Acids and different Organic Bases: Lorenzo L. Lloyd and Dr. J. J. Sudborough.—The Thermal Effects of Dilution: J. Holmes Pollok.—The Changes of Volume due to Dilution of Aqueous Solutions: F. B. H. Wade.

FRIDAY, JANUARY 20.

ROYAL INSTITUTION, at 9.—Liquid Hydrogen: Prof. J. Dewar, F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Epidemic Cerebro-spinal Meningitis: Dr. Bruce Low.

QUEKETT MICROSCOPICAL CLUB, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Results of Rain, River and Evaporation Observations made in New South Wales during 1897: H. C. Russell (Sydney).—Iowa Geological Survey Annual Report, 1897, &c. (Des Moines).—The Last Link: E. Haeckel (Black).—Annual Report of the Smithsonian Institution, to July 1896 (Washington).—Geographical Journal, Vol. xii. (Stanford).—Notes from a Diary in Asiatic Turkey: Lord Warkworth (Arnold).—The History of Mankind: Prof. F. Ratzel, translated, 3 Vols. (Macmillan).—The Swastika: T. Wilson (Wesley).—Mathematical and Physical Tables: J. P. Wrapson and W. W. H. Gee (Macmillan).—Bush Fruits: Prof. F. W. Card (Macmillan).—Elementary Mathematics: J. L. S. Hatton and G Bool (Whittaker).—Studien über Hirsche: Dr. H. Nitsche, Heft 1 (Leipzig, Engelmann).—Grundriss einer Geschichte der Naturwissenschaften: Dr. F. Dannemann, ii. Band (Leipzig, Engelmann).—Maryland Geological Survey, Vol. 2 (Baltimore).—The Geology of the Isle of Purbeck and Weymouth: A. Strahan (London).

PAMPHLETS.—A Course of Lectures on Mining. I. The South Wales Coal-field: Prof. W. Galloway (Cardiff).—The Gypsum Boulder of Great Crosby: T. M. Reade (Liverpool).

SERIALS.—Journal of Botany, January (West).—Middlesex Hospital Journal, December (London).—Journal of the Royal Agricultural Society, December (Murray).—Journal of the Royal Statistical Society, December (Stanford).—Reliquary and Illustrated Archæologist, January (Bemrose).—Zeitschrift für Physikalische Chemie, xxvii. Band, 4 Heft (Leipzig).—Transactions of the Wagner Free Institute of Science of Philadelphia, April (Philadelphia).—Observatory, January (Taylor).—Scribner's Magazine, January (Low).—Geographical Journal, January (Stanford).—Knowledge, January (Witherby).—Journal of Anatomy and Physiology, January (Griffin).—Engineering Magazine, January (222 Strand).—Photogram, January (Dawbarn).—Monthly Weather Review, September (Washington).—Annuario Storico Meteorologico Italiano, Vol. 1, 1898 (Torino).—Mind, January (Williams).—Zeitschrift für Wissenschaftliche Zoologie, lxv Band. 2 Heft (Leipzig).—Botanische Jahrbücher, Fünfundzwanzigster Band, 5 Heft (Leipzig).—Atlantic Monthly, January (Gay).—Imperial University, College of Agriculture, Bulletin, Vol. iii. No. 5 (Komaba).

CONTENTS.

THURSDAY, JANUARY 19, 1899.

THE ANATOMY OF THE EARTH'S CRUST.

Earth Sculpture; or, the Origin of Land Forms. By James Geikie, LL.D., D.C.L., F.R.S. Pp. xvi + 320. (London: John Murray, 1898.)

THE sculptor must be careful to mould his drapery so that its fall and fold may accord with the form below; or, if he copies the undraped human form divine, however quick his eye to detect and his hand to represent, if he wishes to follow the curves of beauty with ease and accuracy he must know the position and functions of the muscles and bones upon which the outlines and pose of the body depend.

So in the study of scenery we shall be better able to appreciate the forms presented to us if we understand the causes which have determined them; then we shall look with different eyes on the gently rounded outlines where soft surface-drifts like drapery have clothed the solid rocks, filled up their hollows, and concealed their ruggedness. Still more shall we have the pleasures of imagination heightened when we can, from an examination of the surface, realise the "ribs of porphyry" or the "joints of the limestone" that have determined the configuration and lie of the land before us.

A very useful work for the sculptor would be "Outlines of Human Anatomy for Artists, with Dissections"; but that would not be a work on sculpture; and the book before us might not inappropriately have been called "The Morphology and Physiology of the Earth's Crust, with Sections; being an Introduction to the Study of Earth Sculpture and its resultant Scenic Features." For it includes far more than its title would imply. It is, in fact, a series of essays upon the principles of geology, in which the author keeps in view the question which on his title he has proposed for consideration; and, at the same time, gives great prominence to those aspects of the subject which bear upon certain theories towards the development and promulgation of which he has taken a leading and distinguished part.

He points out that subterranean action merely provides the rough block which the surface agents of denudation subsequently sculpture into shape, and that, with few exceptions, the land features that now meet our eye are the direct result of erosion and accumulation, the modifying influence of which is always more or less conspicuous.

As the work is intended for readers not skilled in geology, the author has not thought it necessary to burden the pages with references, which for the student are indispensable. He has adopted the *a priori* method; and a great part of the work is devoted to explaining what might, could, would, or should be, assuming the prevalence of certain conditions.

The readjustments of a hardening crust to a shrinking nucleus are referred to as sufficient cause of the foldings which have lifted large areas within reach of earth sculpture, and produced the crumplings and great variety of structure observed in many mountain chains. Perhaps mention might have been made of other theories to account for crustal movements, such as the loading of off-shore areas by sediment, and the corresponding lightening of the adjoining areas from which that sediment was derived; the theories of subterranean lakes of molten matter; the changes of volume which accompany chemical, mineralogical, thermal and other changes in the rocks, and so on.

When looking at the subject from the point of view of earth sculpture, the most important point is the more or less yielding character of the rock—whether this be due to its chemical composition as shown in the manner in which a limestone is dissolved, and rocks with potash felspars crumble away; or whether we regard its texture and structure as shown in the manner in which a shale often resists denudation, while a tough massive rock breaks along joints and bedding planes, and is thus readily cut back; or in its relation to the lie of the rocks as shown in the way in which they resist denudation better where they present solid bed-faces to the weather, than where the denuding agents can attack them along the lines of weakness between the divisional planes. Among beds which are horizontal, or only slightly and uniformly inclined over large areas, there will be a greater similarity in the resultant features than there can be if the beds are thrown into sharp folds, so that rapid alternations of rocks of different solubility, hardness, &c., are exposed in ever-varying positions within short distances. These points chiefly are elaborated in the first nine chapters.

Then we have two chapters on the modification of land forms by glacial agency. The work of ice at the present time is described and the traces of similar work in the past, over areas from which the ice has long been removed, are sketched out. It does not, however, necessarily follow that it was more generally extended over either hemisphere. We shall sufficiently account for all the phenomena observed if we admit that the scene of its severest operations has been shifted from time to time.

Among the controverted questions relating to the origin of glacial accumulations is that of the mode of formation of the ground moraine, that is the great mass of clay and rock which is found at the base of the ice, and of which relics are left plastered over the surface of many glaciated regions.

Have the larger fragments, at any rate, worked their way down from moraines and from the sides to the bottom of the ice, where, crushed against one another and driven over the underlying rock, they produce the clay which forms the matrix of the ground moraine and the "flour of rock" which discolours glacial streams? Or is the ground moraine derived chiefly from the rock over which the ice is travelling; does little material reach the bottom of the glacier or ice-sheet from its surface; and has the ice the power of extracting pieces of rock from its bed, and using them as tools to plough up or grind away more?

This last is the view which our author favours, but it involves the concession that some rock fragments mus have got in from above to start the work, as ice, like water in this respect, has practically little eroding power, but moulds itself round obstructions and only operates in denudation as a handle or back to hold the fragments of rock which form the rasp that really does the work.

Many interesting examples are cited of pieces of rock

which appear to have been gouged out of the bed of the glacier stream, but they are all within the range of the minor advances and recessions of the ice, and still leave room for doubt in the minds of those who are inclined to the view that most of the large fragments in the ground moraine have got in from above.

The author has long been engaged in controversy on the causes and mode of operation of glacial agents, and has, as is well known, pronounced views upon the subject; but in a work of this kind we might have expected to find not merely those facts stated which support the author's theories. Yet we look in vain for a sketch of the work of icebergs, floe-bergs, shore-ice, pack-ice, &c., in handing on and distributing material from the higher ground over wide submarine areas.

We can hardly ignore the potent agency of ice-masses, such as that seen by Ross and Parry, and estimated at 1,500,000,000 tons weight, in modifying the surface of the land on which they grounded, and against which they were driven by wind and current with a velocity far greater than that attained by any glacier or ice-sheet.

Icebergs, 700 or 800 feet high, have been seen sailing along off Cape Horn, and we know that the volume of ice below the water would be between eight and nine times that seen above it. Not only must we take account of the tremendous momentum of this stranding ice, but the enormous quantity of débris now carried by floating ice and distributed over the sea-bottom would seem to deserve some notice. The fact calls for some explanation, if it be a fact, that nothing of the kind is recognised among the glacial deposits as having been raised from the sea-bed within reach of observation.

Towards the end of the work, where he is developing a classification of forms, our author gives a separate chapter on coast-lines and another on basins, which last is very much a continuation of the chapters on glacial phenomena. He accepts the glacial origin of most rock basins, though he admits that there are difficulties in reconciling this view with some of the phenomena observed in the outer Hebrides, for instance (pp. 242–244).

He describes the loess of Southern and South-eastern Russia as primarily a flood-loam of glacial times, and considers that much of that occurring in the river valleys of Central Europe has been derived from Alpine lands (p. 192). But any-one who has examined the character and mode of occurrence of the black, dusty Tchernosem of Southern Russia, covering all the surface high and low, continually blown away and washed away and ever renewed, will have his confidence in those wide generalisations as to the origin of all loess considerably shaken.

England is the country of all countries for the study of the fossiliferous rocks; America is too broad, Switzerland too high; in England the evidence is fairly complete within easy distances, and is generally accessible. So it is in Scotland that we find the most readily available epitome of the phenomena of rock-structure. It is, therefore, to be regretted that a larger portion of the illustrations were not taken from actual sections seen in Scotland or England. The work would have been more valuable if the facts could have been verified in the field in a summer's trip. As it is there are only a dozen Scotch sections, including the two excellent photographs of weathered granite, and a couple from England, while thirty-five of those of which the locality is given are taken from foreign works. The remaining forty-two have no locality—that is, are only diagrams, and those not very satisfactory.

If the glossary was intended to be confined to words used in this work, there are not many which it would not have been better to have explained or paraphrased in the text, and most of them need no further explanation than should be gained from the context; while some need not have been used at all, for it is not easy to state a case in which anything is gained by using epigene and hypogene instead of above-ground and under-ground. Of those that do seem to require a note, some—for instance, "tectonic"—are not mentioned in the glossary. But if it is a general glossary to assist those who might wish to follow up the line of inquiry by reading special memoirs, the information is not wide enough. It might have been helpful to have enabled the reader to discriminate between diorite and syenite, dolerite and basalt, and so on; and, if the origin of the word is explained, to point out that diorite was so named from the ease with which the component minerals could be distinguished as compared with dolerite which was obscure, although such rough distinctions were not those upon which modern petrologists rely for their classification.

However, after cautioning our readers that there are other interpretations of many of the facts observed, besides those offered in this work, and pointing out some slips which will probably be corrected in the next edition, we can recommend them to read this able and clearly arranged succession of essays upon an interesting group of natural phenomena.

THE OASIS OF SÎWAH.

From Sphinx to Oracle. By A. Silva White. Pp. xvi + 277. 2 Maps, and 57 Illustrations. Hurst and Blackett, 1899.)

UNDER a somewhat fantastic title Mr. A. Silva White has published an account of a journey which he made in the early part of the present year to the Oasis of Sîwah, the Oasis that was made for ever famous by Alexander the Great, who visited it after he had conquered Phœnicia and Egypt. Mr. White's visit seems to have been prompted by an inspiration which came upon him after he had drunk deep of the "sonorous silence" of the desert, at "midnight hours," "in the radiance of a full-moon." We wish that the inspiration had been a thing born of the day, and that it had counselled him to persevere in making preparations which took the form of studying the history and languages, ancient and modern, of the land over which he had resolved to travel. His original object seems to have been to visit Jarabub, the stronghold of the powerful "Senussi" sect of Muhammadans, which lies rather more than one hundred miles from Siwah, in a direction more west than north. As Mr. White talks of his "political studies" we may assume that he had some definite mission when he set out for this uninviting spot; we have no right to inquire what the mission was, and we can only offer him our sympathy in his failure to reach the place where he fain would have been. To this failure we perhaps owe the appearance of his work.

The Oasis of Sîwah has within the last century been visited by W. G. Browne, Hornemann, Cailland, Minutoli, Drovetti, Ricci, Rohlfs, all of whom have written accounts of their journeys there, and of the antiquities of the place; several other travellers have sojourned there for short periods, and thus the Oasis is well known. The ancient Egyptians, as far back as the time of Seti I. (*circ.* B.C. 1350), called this Oasis "Sekhet-Ami," *i.e.* the "Field of the *Am* trees." And though such a name might well be given to any of the Oases, we are quite certain that Sîwah was thus called, for a text at Denderah describes Sekhet-Ami as "a name given to the mountainous countries of Qauuti which lie to the west of the border of the land of "Aḥ." Now Aḥ is the Oasis of Farâfra, which lies to the south of the Oasis Minor of the Romans (see Brugsch, "Reise nachden Grossen Oase," Plates xxiii. and xxiv., Leipzig, 1878).

It is probable that a small temple dedicated to some ram-headed god existed here in early times, but up to the present we have no definite evidence of the fact. In the time of Alexander the Great the god worshipped at the Oasis of Sîwah was identified with Amen-Rā, whose title was *Sept ābu* or "two-horned," and the Macedonian conqueror regarded him as his father. The Ptolemies did much for the Oasis of Sîwah, and it is more than probable that the temples and buildings there, which have been fully described by the old historian Diodorus, and by modern travellers, belong to the period of their rule over Egypt. The Arab writers knew nothing of the ancient history of Sîwah, as we may see from the meagre summary given by Yakût in his Geography (ed. Wüstenfeld, tom. iv. p. 873), and the information which they supply is generally distorted and legendary.

But to return to Mr. White's book. Of the twenty-six chapters of his narrative the greater number are devoted to detailing the incidents of his daily journey, and conversations with members of his caravan, and personal feelings and impressions about men and things. One chapter, based upon the works of French writers, is devoted to the Senussi, or followers of a certain "mad mullah" called Sidi Muhammad ibn Ali es-Senussî, who flourished in the first half of this century; three to the antiquities of Sîwah; one to a description of Jarabub, and so on. In the chapter headed "Ma' lèsh" he tells us that Egyptologists have assured him that he "has opened up the Oasis to them and to others," but how has he done it? We have examined his book carefully, but can find few antiquarian facts which were not known before; indeed, if he had drawn upon some work like Parthey's "Das Orakel und die Oase des Ammon," his book would have been more valuable and more interesting. He gives a description of a tomb in the "hill of the mummies" (*i.e.* Gebel Mûtâh, or "hill of the dead"), but without the hieroglyphic texts. This tomb Mr. Daressy first dated at B.C. 1200, but afterwards he wisely brought its date down to the time of Alexander the Great.

In Mr. White's description of the tomb we find *Amsel* instead of Amset, and *Duau-mulef* for Duau (*or* Tuau) -mutef, and *Kebh-sennef* for Kebh-sennuf; Prof. Sayce, who supplied the description, must be held guiltless of such mistakes as these. Mr. White's Arabic also is not above suspicion. Thus he writes *Ruffir* for Rafiyyeh, "shawl for the head" (p. 31); *Quies* for Kuwayyes, "good, pretty" (pp. 47, 69); in the Arabic name of God (p. 119), the *teshddîd* is over the wrong *lam; ma'es es-salâmeh* means "with peace," *i.e.* "good bye" (p. 196); *Ruttab* for *Rutub* (p. 232); &c. In short, Mr. White's book afforded him, no doubt, great pleasure in writing, but it seems that his want of knowledge of what other travellers have written about Sîwah has made him exaggerate the importance of his journey to archæologists.

Archæologists want copies of all the inscriptions which they can get from the Oases, and all the information possible; but the present state of Mr. White's archæological knowledge hardly entitles him to claim to have opened Sîwah to the Egyptologist. If he will first make his studies, and then visit the Oracle of Ammon, we shall be glad to hear what he has to say. His present work is written in a rather flippant style, and a sentence like the following jars upon us:—

"Abd-el-Gade did not reply." But his answer lay in his "embarrassed silence. Damn!" (p. 176). Mr. White's footnote to this is "An execration (*lapsus calami*)."

AN ITALIAN TEXT-BOOK OF PHYSIOLOGICAL CHEMISTRY.

Chimica Fisiologica per uso dei Medici e degli Studenti. By Dr. Filippo Bottazzi, libero docente di Fisiologia in Firenze. Vol. I. "Chimica Fisiologica generale." Pp. xv + 428. Vol. II. "Chimica Fisiologica speciale." Pp. xii + 465. (Milan, 1898.)

THIS work is initially interesting as being the first substantial text-book of the subject published by an Italian for Italian students. But it is much more than this. It is extremely well written, and differing as it does in many respects in both form and substance from the works with which we are already familiar, it is very suggestive as to many points of view from which the subject may in the near future make its most profitable advance.

A text-book of physiological chemistry must really be neither a treatise on physiology nor on chemistry. If it deals with the subject under the heads of respiration, nutrition, &c., it is too strictly physiological. On the other hand, if it consists chiefly of a list of substances and a description of their properties and methods of preparation and estimation, it is too chemical. Hence the author has divided the work into two parts. Of these, Vol. i. deals with general physiological chemistry, and studies the materials introduced into the living organism, the changes they undergo in the alimentary canal as they become assimilable, the mechanisms concerned in their absorption and assimilation, and finally the products of their disintegration in the living tissues as sources of energy. This complete metabolic cycle is treated in separate chapters (2–5), devoted to each group of the simple food-stuffs taken in the following order: "Inorganic substances" (water, salts, and certain gases), "Carbohydrates," "Fats," and "Proteids." These are preceded by a chapter on "The Elements," and followed by two dealing respectively with "Colloids" and "Ferments and Enzymes." This arrangement might at first

appear to be purely chemical, but in fact it is not; for although the chemical nature of the several substances and the more exact methods employed for their qualitative and quantitative determination are carefully recorded, the whole is looked at always from the purely physiological point of view of animal metabolism.

Dr. Bottazzi deserves special praise for having clearly realised the importance of the application of the more elementary ideas of physical chemistry to physiological and biological problems. He has hence given us here and there throughout this work concise but very clearly written statements of those conceptions of physical chemistry which are essential to the study of the properties of living matter, and which have so far never appeared in any existing text-book of either physiology or physiological chemistry. Thus in chapter ii. (pp. 37–64) he has dealt with the ideas which have led to the establishment of the modern theory of solutions, such as osmotic pressure, vapour tension, freezing-point, electrical conductivity, internal friction and viscosity. In chapter vi. (pp. 392–405) he gives the phenomena and laws of diffusion, dialysis, osmosis, and imbibition. This chapter is, moreover, of peculiar interest as dealing specially with the colloids as a group, and in a way not found in other text-books. This is most valuable when we remember that the animal organism is chiefly composed of colloidal substances, that they possess peculiar physical and chemical properties, due to the nature of their molecular aggregation, independently of those due to their constituent elements, and that these properties, continually making themselves felt, must play an important part in determining the mode of recurrence of vital processes.

The second volume opens with a long chapter (pp. 1–108) on "The chemistry of the living cell," as a suitable connecting link between the general physiological chemistry dealt with in the first volume and the special treatment in the second. In this the author has endeavoured, and with great success, to bring together all the scattered knowledge bearing upon the subject of the cell as the living unit, or, as he says, on the general problems of biological chemistry. This chapter is most instructive, and well worth reading from every point of view. Here again we find excellently clear explanations and applications of the phenomena of surface-tension, diffusion, osmosis in its strictest sense, and diosmosis; of plasmolysis and isotonicity. The succeeding chapters deal consecutively with the special subjects of blood, lymph chyle and serous fluids, the fluids of the organism in general, connective tissue, muscle, nerve, sense-organs, internal secretions, and so forth. The last three chapters treat of the digestive secretions, the liver, kidneys and urine.

In both volumes the several chapters conclude with a copious, well selected and representative bibliography of the subject-matter, carefully quoted in chronological order.

This book is full of good things, clearly stated and discussed suggestively. It would be easy to make a selection of them; but the list would be long, and we refrain from giving it in the hopes that thereby curiosity may be whetted and a desire aroused to read the original.

S. L.

OUR BOOK SHELF.

Flashlights on Nature. By Grant Allen. With 150 illustrations by Frederick Enock. Pp. viii + 312. (London: George Newnes, Ltd., 1899.)

THIS is a bright and amusing account of a number of natural structures and problems. The economy of aphides, shrikes, earwigs, wasps, gnats, spiders and Hessian flies, of the Alpine Soldanella, clover, gorse, and water-weeds in winter is described in lively words and illustrated by figures, which are often both attractive and novel. The drawings of the earwig and Hessian fly are well worth the attention of professed naturalists; those of the gnat contain some small errors. Mr. Grant Allen has banished nearly every one of the technical terms which impede unlearned readers. In this he has done well, though we think that a technical name here and there in a footnote might have guided some few readers to fuller information.

Authors of elementary books do not feel bound to give chapter and verse for all their statements. But Mr. Grant Allen has gone too far in leaving out. He has rewritten Kerner's account of the Soldanella, the frog-bit and the curled pondweed, and adapted Kerner's figures of all three, without one word of acknowledgment.

L. C. M.

Spherical Trigonometry (Theoretical and Practical). Pp. viii + 116. By W. W. Lane. (London: Macmillan and Co., 1898.)

THE author of this book, who is one of the naval instructors on H.M.S. *Britannia*, has brought together the most important rules which are used in the solution of spherical triangles, and, after demonstrating the theory of each, introduces worked-out exercises for illustrating their actual use. The arrangement of the text seems to be well done, the student being led first to understand the geometrical relations between circles of a sphere, their spherical triangles, and after that the geometrical relations between the sides and angles of spherical triangles. Chapter iv. introduces for the first time the trigonometrical ratios, and this is followed by chapters in which the solutions of various types of triangles are dealt with. Throughout these the author makes the solution of the various problems very clear to the student by means of the figures which accompany the text, but the reader is nowhere directly advised to always construct figures for himself.

Although the author demonstrates and illustrates the use of the L haversine and tabular versed sine tables (tables which, by the way, are not used at examinations by the Civil Service Commissioners), he assumes that the reader knows the meanings of these terms. Perhaps it would have been more complete if these terms had been again defined. Thus we find that up to the end of the sixth chapter the beginner has been working with sines, cosines, tangents and their reciprocals; but in the next chapter, in the solution of a certain triangle, he is immediately confronted with

$$\text{hav } A = \frac{\text{vers } A}{2} = \frac{1 - \cos A}{2}, \text{ \&c.},$$

without any previous hint as to what hav A or vers A means, although a more advanced student could find this out for himself. This, however, is a somewhat minor point, for the author provides other rules independent of these terms. Those, however, for whom this book is intended—namely, students preparing for examinations at the Royal Military Academy, Lieutenant R.N., B.A. London, &c.—will find the present treatise an excellent guide to the solution of spherical triangles, and the large number of well-chosen examples which are appended should prove useful.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Duke of Argyll and Mr. Herbert Spencer.

HAD I read Mr. Spencer's reply to the Duke of Argyll in 1888, I should have been even more astonished than the writer of the "Counter Criticism," that the Duke should have sanctioned the publication of his essays in their present form without a word of warning to his readers, that Mr. Spencer had not only not sanctioned but had explicitly denied the interpretation which the Duke had forced upon his analysis of the term "survival of the fittest." Any person would conclude from the first essay that Mr. Spencer had altogether abandoned this term, and (by implication) the factor of organic evolution expressed by it. I am sure that biologists will be generally glad to have it again authoritatively from Mr. Spencer himself that he is still so far Darwinian. He will also bear with me, I hope, when I point out that the mass of literature which the working man of science has to digest at the present time is so great that very few have time to seek light in the pages of the current magazines. Certainly we do not turn to these publications as a rule for information on scientific questions, and, I am bound to add, that the principles which determine the selection of writers on scientific subjects for such magazines have always appeared to me to be a profound mystery. It is not mere flattery when I state that we are in the habit of regarding Mr. Spencer's magazine contributions in the light of "preliminary notices," and that we always look forward to having them in a collected form at some later period.

With respect to the apparent change of attitude on the question of the relative importance of direct and indirect equilibration, I can, of course, only accept Mr. Spencer's explanation that the great prominence into which he has of late years brought the first of these factors, has led biologists in this country to suppose that he attaches more weight to it than he did formerly. It may be also that since the admissibility of this factor has been seriously questioned by those who accept the views of Prichard, Galton and Weismann, the attitude of each party has become unconsciously stiffened towards the other. In the passages from his "Principles of Biology," referred to by Mr. Spencer in his letter (which passages I had by no means forgotten), it is made perfectly clear that even at the time of writing that work he went beyond Darwin in the part assigned to direct equilibration. In his "Factors of Organic Evolution," published in 1886 in the *Nineteenth Century*, and collectively in 1887, Mr. Spencer certainly produces the impression that he is inclined to go still further in this direction:—

"Was the share in organic evolution which Mr. Darwin latterly assigned to the transmission of modifications caused by use and disuse, its due share? Consideration of the groups of evidences given above will, I think, lead us to believe that its share has been much larger than he supposed even in his later days" (p. 33)

"But the fact we have to note is that while Mr. Darwin thus took account of special effects due to special amounts and combinations of agencies in the environment, he did not take account of the far more important effects due to the general and constant operation of these agencies" (p. 46).

"But gradually with that increase of activity which we see on ascending to successively higher grades of animals, and especially with that increased complexity of life which we also see, there came more and more into play as a factor, the inheritance of those modifications of structure caused by modifications of function. Eventually, among creatures of high organisation, this factor became an important one; and I think there is reason to conclude that, in the case of the highest of creatures, civilised men, among whom the kinds of variation which affect survival are too multitudinous to permit easy selection of any one, and among whom survival of the fittest is greatly interfered with, it has become the chief factor: such aid as survival of the fittest gives, being usually limited to the preservation of those in whom the totality of the faculties has been most favourably moulded by functional changes" (p. 74).

I have not the least desire to raise once again the whole question as to whether "direct equilibration" plays any part at all in the development of species, but such passages as those above quoted, and generally the whole tendency to exalt this factor in the essays from which they are quoted, has produced a very widespread notion that Mr. Spencer has diverged more widely from Darwin now than he did in 1864. Personally I can only express satisfaction that Mr. Spencer has himself disillusionised us.

January 13. R. MELDOLA.

The late Prof. George James Allman, as a Botanist.

IN the notice of my distinguished namesake and friend—the late George James Allman—which appeared in NATURE of December 29, 1898, it is stated:

"Allman's first paper was a botanical one, 'On the Mathematical Relations of Forms of Cells of Plants,' and it is worthy of note that in this he in a sense anticipated one of the most recent among our biological departures."

This is not so. I send you herewith a copy of an "Abstract of a Memoir on the Mathematical Connection between the Parts of Vegetables," by William Allman, M.D., who was Professor of Botany in the University of Dublin, 1809–1844, and the predecessor of the late George James Allman in the chair. The memoir is plainly the paper referred to above, and was read before the Royal Society in the year 1811. GEORGE J. ALLMAN.

St. Mary's, Galway, January 2.

THE paragraph in my obituary notice of the late George James Allman, cited by Prof. George Johnston Allman, was intended to refer to a paper read before the British Association in 1835, entitled "On the Mathematical Relations of the Forms of the Cells of Plants," which heads the list of works ascribed in the Royal Society's Catalogue of Scientific Papers to George James Allman, and not to that by William Allman mentioned in the accompanying letter by his son, of which at the time of writing I was ignorant. While collecting data for my necrology of George James Allman, my suspicions were aroused by the fact that in the original form the paper alluded to by me is attributed but to a "Dr. Allman"; assuming, however, that the Royal Society's Cataloguer must have had authority for definitely associating it with George James Allman, I did not inquire further. In consideration of the point now raised, the matter becomes further complicated by the fact that the President of the Linnean Society, in making the award of the Society's Gold Medal to the late George James Allman in 1896, was, at my instigation, led to refer (*Proc. Linn. Soc.*, 1895–1896, p. 30) to the same paper in terms apposite to those of my obituary notice now under discussion. The memoir by William Allman, referred to by Prof. George Johnston Allman, is preserved in the Department of Botany, British Museum, together with a copy of an abstract of the same printed privately in 1844, as has been pointed out by my colleague at the Linnean Society, Mr. B. Daydon Jackson, in his article "William Allman" in the Dictionary of National Biography, on Prof. Allman's own authority, and by Prof. Percival Wright in his "Notes from the Botanical School in Trinity College, Dublin" (No. 1, p. 3); (*cf.* also Messrs. Britten and Boulger's "Index of British and Irish Botanists," p. 3). And on inspection, I find them accompanied by a letter to Robert Brown, dated 1844, which seems to show that the abstract was printed at his suggestion, *apropos* of an application by W. Allman for an appointment for which testimonials were being sought. MS. and abstract, and the paper to which I alluded, however, though cognate, are unquestionably distinct; and, on making further inquiry since the receipt of Prof. Allman's letter, I have been interested to find in the British Association's Index for the years 1831–1860 yet another of a similar character, recorded (but in title only) under the name of George James Allman. Mr. Griffith, the Secretary of the British Association, has very generously aided me by looking up the original records in his possession, and other reports and publications likely to bear on the question: and he informs me that he has no doubt whatever that the series of papers under discussion were by William Allman, pointing out that the paper regarding which I was misled by the Royal Society's Catalogue and British Association's Report is rightly attributed to him, on authority, in Poggendorff's "Handwörterbuch." Further consideration of the dates of events in the lives of the two Allmans fully bears this conclusion out. The series of papers were clearly expressive of successive phases in a long-cherished idea revolving in its author's mind for a period of nearly forty

years; and the whole source of confusion lies in the failure of those responsible for the British Association Reports of the time to insert the author's initials—the Allmans having been apparently referred to indifferently as merely "Professor" and "Dr."

While thus my precise statement concerning George James Allman's claim to distinction which is involved must be dissociated from his memory, perusal of his published writings still justifies us in regarding him as a scientific botanist of renown.

It has been pointed out to me that my reference to the late Beete-Jukes might be interpreted to mean that he was a professor in Trinity College, Dublin; and, in event of this possibility, I would remark that no such idea was intended. George James Allman was appointed professor of botany in Dublin University, in succession to William Allman, in 1844; resigning the appointment in 1856. Joseph Beete-Jukes became director of the Irish branch of the Geological Survey in 1850; and during the whole period of George Allman's occupancy of the Dublin botanical chair, the late Samuel Haughton was professor of geology. The allusion to the late Beete-Jukes was introduced into my notes by the kindness of a relative of the late George James Allman, and it is inaccurate as concerning the word "Professor," as I now find to be also the case with the word "Regius" as applied to the Dublin chair itself (which I owe to the obituary notice in the *Times* of November 28, 1898). "Professor" (line 19) and "Regius" (line 18) must accordingly be deleted from my article by those who would make further use of it; and I would remark that by "Grumera" (column 4), Gunnera is meant.

My best thanks are due to Mr. Britten, Mr. Griffith, and Prof. Percival Wright, for friendly assistance and advice in this interesting little bibliographic research, the limitations of which I appear to have by no means exhausted. G. B. HOWES.

Royal College of Science, London, S.W., January 9.

Since the above was written, we have received the following from Prof. Allman.—ED.

When writing the above I did not recollect that my father —many years later—read at the meeting of the British Association in Dublin (1835) a paper "On the Mathematical Relations of the Forms of the Cells of Plants" (Brit. Assoc. Rep. 1835, part ii. p. 79). This paper is erroneously attributed to Dr. George James Allman in the Catalogue of Scientific Papers of the Royal Society of London.—G. J. A.

January 16.

The Density of the Matter composing the Kathode Rays.

THE question of the size, charges and velocities of the carriers in the kathode rays has been made the subject of investigation by Prof. J. J. Thomson, Lenard, and others. I do not know whether it has been noticed that, by taking the values which have been obtained for the ratio of charge to mass, and for the velocity of the particles, in connection with the observed fact that a shaft of rays from a plane kathode retains its cylindrical form unaltered as it passes across the tube, we can arrive at a limiting value for the mass per unit volume of the matter composing the rays.

Take for simplicity a uniform circular shaft of charged particles travelling with velocity u. Let the mass per unit volume be m, the charge per unit volume e, the radius of the section a, and the velocity of light v. The shaft constitutes a current of strength $eu \cdot \pi a^2$. The magnetic force at the boundary is

$$H = \frac{4\pi}{2\pi a} eu\pi a^2 = 2\pi aeu.$$

If we take unit volume at the boundary, it will be subject to an electro-magnetic force, inwards,

$$= H \cdot eu = 2\pi ae^2u^2.$$

The same unit volume will be acted upon further by an electrostatic repulsion outwards of amount $2\pi ae^2v^2$ in electromagnetic units.

Hence the resultant force on it will be

$$2\pi ae^2(v^2 - u^2) \text{ outwards.}$$

Now if ρ be the radius of curvature of the outer boundary, we have

$$\frac{mu^2}{\rho} = 2\pi ae^2(v^2 - u^2),$$

or the curvature is

$$\frac{1}{\rho} = 2\pi a\left(\frac{e}{m}\right)^2 m\left(\frac{v^2}{u^2} - 1\right)$$

We know that this curvature is small.

Taking the numbers given by Lenard (*Wied. Ann.*, 65, p. 504), we may put, roughly,

$$\frac{e}{m} = 6 \times 10^6$$

$$\frac{v}{u} = 4$$

giving

$$\frac{1}{\rho} = 2\pi a \cdot 36 \cdot 15 \cdot 10^{12} \cdot m$$

$$= ma \times 3{\cdot}4 \times 10^{15}.$$

Therefore m must be smaller than order 10^{-15}, whereas the average density in the tube, that of air at the pressure of a fraction of a millimetre, is of the order 10^{-7}.

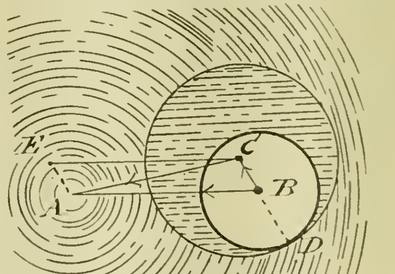
If we do not suppose that m and e are constant, but take them as functions of the distance from the axis of the shaft, we arrive at the above limit for the average density.

Queen's College, Belfast, January 9. W. B. MORTON.

Attraction in a Spherical Hollow.

AMONG the papers of the late Prof. Peter Alexander, of Anderson's Medical College, Glasgow, I find the enunciation of an interesting theorem in attraction. "The attraction on a particle of unit mass, in a spherical hollow in a sphere of uniform density, is at all points of the hollow parallel to the line joining the centres of the sphere and hollow, and is of constant magnitude equal to $\frac{4}{3}\pi c\sigma\kappa$. Where c is the distance between the centres, σ the density of the sphere and κ the attraction of unit mass on unit mass at unit distance."

I venture to give the following informal proof. Let A be the centre of sphere which may be supposed to be indefinitely great, and B a particle at the centre of the spherical hollow. Then the attraction on B is towards A, and is proportional to BA if the hollow be indefinitely small (see Dr. Tarleton's "Introduction to the Theory of Attraction," p. 13). But the removal of the spherical mass round B as centre in no way alters the attraction on the particle B. This proves the theorem for the central point. If the centre of the sphere were at C the attraction on B would then be BC in the same way. Let the



particle be now placed at C any point in the hollow. Produce CB to meet the hollow sphere at D. If the spherical hollow be enlarged so that C is its centre and CD its radius, the force of attraction on C will now be CA. Restoring the mass to the space between the new and the original hollows, subjects the particle at C to an additional force, equal and opposite to BC. Hence the force exercised on the particle at C in the original hollow is CE, which is parallel and equal to BA.

This furnishes a good example of the theorems (*ibid.*, pp. 60 and 94), that if one or other the amount or direction of the attraction within unoccupied space be constant, then must both be so.

There is probably a formal rigid proof of his theorem among my brother's papers. He told me that some practical application might be made, by having the hollow just touching the

surface of the solid sphere, at which point there might be a hole or door through which a small suspended magnet could be introduced into the interesting field of force.

THOS. ALEXANDER.

Engineering School, Trinity College, Dublin, January 2.

Fourier's Series.

PERMIT me to make a few remarks on the notes of Prof. Willard Gibbs and Mr. Love in NATURE of December 29, 1898.

Using Prof. Willard Gibbs's notation, write fx_n for the series

$$\sin x - \tfrac{1}{2}\sin 2x + \tfrac{1}{3}\sin 3x - \ldots \pm \frac{1}{n}\sin nx,$$

and let C_n denote the curve whose equation is $y = 2fx_n$.

Consider the two curves C_n and C_{n+1}. Then it is easily seen that these curves intersect, when x = any multiple of $\pi/n + 1$; and (omitting proof, so as not to cumber your pages with calculation, which is not difficult) it will be found that one of the curves passes through the extremities of the maximum ordinates of the other, and the other through those of the minimum ordinates of the first, in each case the curves cutting one another at an angle whose tangent is 2. Hence if d is the distance along the ordinate of one of these points of intersection from the slant part of the limiting broken line ($y = x$), on one of the curves the like distance will be less than d on one side of the point, and greater than d on the other side. The statement of Prof. W. Gibbs that, "if any small distance be first specified, a number n' may be then specified such that for every value of n greater than n' the distance of *any* point in C_n from the broken line, and of any point in the broken line from C_n, will be *less* than the specified distance d," is therefore incorrect. It is doubtless true that C_{n+1} is, as a whole, nearer to the broken line than C_n, but it is not true that every point in it is so.

The above, in fact, shows, for a particular case, what Mr. Love has remarked in more general terms in his note.

I cannot follow Mr. Love in his remark—if, as I suppose from his argument, it is intended to be general and not limited to the particular illustration—when he says "Thus, in the passage to the limit, every point near the vertical part of the broken line disappears from the graph, except the points on the axis of x."

May we not as legitimately reason thus? The maximum ordinate of C_n nearest to $x = \pi$ is that for which $x = n\pi/n + 1$. There is a point P corresponding to a value of x between $n\pi/n + 1$ and π, whose ordinate is any fixed fraction (the half, say) of the above maximum. If now n be increased without limit, P will in the limit coincide with the point $\left(\pi, \frac{\pi}{2}\right)$. Thus the vertical part of the broken line, in this way of arriving at the limit, *will* appear in the graph.

Would it not be more correct to say that, when n is infinite, the limiting curve has ordinates for the value $x = \pi$ indeterminate within the limits $-\pi$ and π?

R. B. HAYWARD.

Shanklin, Isle of Wight, January 5.

The Decrease of Swallows and Martins.

WHAT an age of contradictions this is! a statement is put forth one day by some one who has apparently every reason to be an authority, and it is contradicted the next day by some one else who also appears to have good ground to support his contradiction.

Whom are we to believe?

Before preparing the paper on the decrease of the Hirundinidæ, which I was privileged to read at the conference of the Society for the Protection of Birds, I sought for, and obtained a large amount of valuable information on the subject, and embodied the chief details in my paper.

The most useful contribution concerning the destruction of small birds, including swallows, in Italy, was from the pen of Mr. W. J. Stillman, who was, until recently, the *Times* correspondent in Rome, and who, in the course of a letter published in the *Times* of August 23, 1898, wrote:—"Swallows are *netted* by the thousand as they come to the shores of Italy in their northward migration, and are *eaten as food*. They are also caught in quantities in the most cruel manner with artificial flies and fish-hooks." [The italics are mine.]

Another correspondent wrote to me personally, telling of the wholesale slaughter of birds in the neighbourhood of Florence, and in other parts of Italy, and although he does not, in his letter, actually specify swallows and martins as amongst the slain, yet it is not unreasonable to conclude they were amongst the many small birds which he has seen daily in Florence, piled up four or five deep on flat barrows, some five feet by three, and he also says he had been told that the *netters* are the real cause of the extraordinary absence of birds throughout Italy.

For many years past great complaints have been made against the French and Italians because of the great destruction of wild bird-life in the two countries; many people have protested against it, including "Ouida," who is, I believe, a resident in Italy, and who has on several occasions used her pen in defence of the birds.

My statements about the destruction of swallows in France were based on reports issued by the Agricultural, and the Zoological Society of France, the report of the latter body being subscribed to by three observers who had made special inquiries on the subject, and who wrote:—

"In the springs of 1887 and 1888, hampers were addressed to the naturalists of Paris containing dead swallows in the flesh, not only by hundreds, but by thousands. One lot of these birds, destined for the millinery trade, was spoilt owing to the impossibility of preserving them from putrefaction. These swallows had been captured in the Department of the Bouches-du-Rhône by means of three procedures—the net, by fish-hooks, and by electric wire."

In the report issued by the Agricultural Society of France, in 1894, it was stated on the authority of M. Rosier (delegate of the Society of Agriculture of the Gironde), "that in his district, at the season of their passage, there are killed every year more than a million of the Hirondelles."

The foregoing extracts will, I venture to think, prove that I did not speak without my book when I partly ascribed the decrease of the Hirundinidæ in this country to the massacre of such numbers of the family in France and Italy; and as a further proof that they do not come to our shores so abundantly as formerly, I have received letters from the keepers of some of our lighthouses, who report that during recent years they have remarked a very great falling off in the numbers of these birds at the time of the spring migration, and have wondered as to the cause.

In our own country the main disturbing element is, without a shadow of a doubt, to be found in the action of the house-sparrow, who has constituted itself a most persistent enemy of the swallows, especially the house-martin, whom it harries in every direction, and has been in many instances the cause of whole colonies of martins forsaking their old haunts.

I cannot altogether agree with the theory that the absence of the swallows in their old numbers is due to climatic changes, or to the decrease of their insect food; last summer this part of the country was swarming with winged insect life, so much so that some days the air seemed almost alive, and our rose and fruit trees were smothered with them, but in this town and its immediate neighbourhood swallows and martins were quite scarce, although all the local circumstances are, one would think, favourable for them in every way.

If climatic changes are an affecting influence against the coming of the swallows to this country, why are not other spring migrants affected in the same way? *i.e*, the chiff-chaff (a much earlier immigrant than the swallow), the nightingale, the willow-wren, or the wagtails and many other species, which during the last few years have shown a tendency to increase. I do think, however, that the atmospheric conditions of some of our towns, especially where there are large factories and other sources of noxious vapours, may be the means of keeping the swallows away locally.

My belief then is, that a very large number of the Hirundinidæ are prevented from coming to us by the slaughter which awaits so many of them in the course of their journey from their winter quarters; and that when those who do survive the perils of the way ultimately reach this land, they are interfered with to such an extent by the sparrows that they are not able to multiply so freely as they would do under more favourable conditions, and so their number is kept reduced from year to year.

I am still seeking for trustworthy information from personal observers, and shall be most grateful for any communication that may be sent to me at this address, especially as I propose extending my paper and publishing it in the form of a pamphlet, in which will be included extracts from the letters which have come to me from all over the country.

J. HERBERT ALLCHIN.

Esher, Bower Mount Road, Maidstone, January 7.

FOSSIL VERTEBRATES IN THE AMERICAN MUSEUM OF NATURAL HISTORY.

IN May 1891, the American Museum of Natural History began to form its historical collection of the Fossil Vertebrates of North America. The new department of Vertebrate Palæontology was established for this purpose, and the Curator organised a series of expeditions to different formations in the Rocky Mountain region, beginning with the older tertiaries, and mainly under the direction in the field of Dr. J. L. Wortman, the well-known collector and investigator. Between 1891 and 1897 twenty distinct expeditions have been sent out, in several instances the same regions being revisited two or three times, with the object of securing complete material of certain types. In 1894 and 1895, and upon a larger scale in 1897, the explorations were extended into the Mesozoic rocks for fossil reptiles. But the main strength of the work hitherto has been among the fossil mammals, and the Eocene and Oligocene collections are now especially complete, embracing the remains of 3000 individuals determined stratigraphically with accuracy, and establishing several new sub-horizons of great importance. In 1895 the famous series of mammalian fossils brought together by the late Prof. Cope was added to these collections, embracing types of 555 species and upwards of 6000 individual specimens.

There are many sides of this work of interest to the vertebrate palæontologist, but we may describe here only the effort which has been made to secure for the Museum complete skeletons of the most typical forms in different geological periods. To every one familiar with the rarity of the older Tertiary types, the difficulty of this undertaking will be at once apparent. It is very seldom indeed that a complete skeleton like that of *Phenacodus* is found together in the older rocks. In ninety-nine cases out of a hundred, the skeletons are largely or wholly dissociated. Another difficulty is, that in the rare cases of association the skeletons are apt to be severely crushed beyond the possibility of reconstruction. In such cases only a drawing can be made. Despite all this the Museum has succeeded by persistent attacks upon one horizon after another, and by superior methods of field work, in securing a very representative series of complete skeletons partly belonging to single individuals, in some types to three or four different individuals, and in other types, as in the skeleton of *Teleoceras*, to a very large number of individuals. With the arrival in the Museum of this material in the crude condition from the field have arisen the mechanical problems of mounting these skeletons in various ways. This has received prolonged study, and after numerous experiments and some failures has now reached a high degree of perfection.

FIG. 1.—*Aceratherium tridactylum*, hornless rhinoceros from the Upper Oligocene of South Dakota. High relief mounting of a single laterally crushed skeleton.

It was at first believed impossible to mount a stone or fossilised skeleton free like a recent skeleton, and the

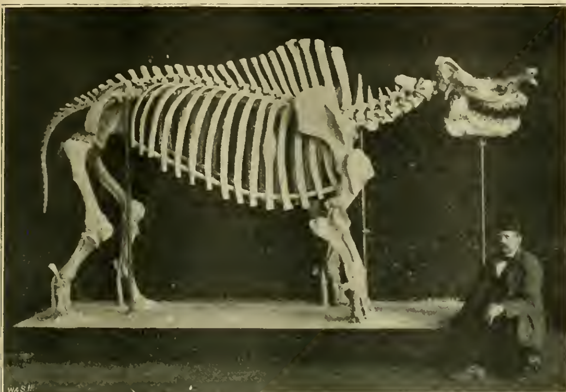


FIG. 2.—*Titanotherium robustum*, skeleton of one of the largest species, female. From the Lower Oligocene of South Dakota.

first experiments upon a large Creodont or primitive Carnivore, *Patriofelis*, the bones were placed in high relief upon a background of matrix resembling the original rock in which the specimen was found. This method was also adopted in the skeleton of *Acera-therium tridactylum* (Fig. 1), which happened to be very much crushed laterally, and was therefore peculiarly fitted for mounting in relief. The result, as shown in the photograph, was highly successful. This skeleton, which is entirely original except the left fore limb, conveys to the visitor the idea of having been literally hewn out of the rock,

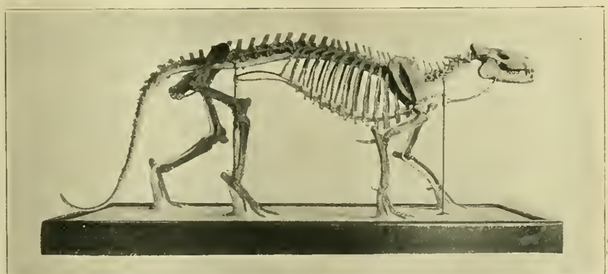


FIG. 4.—*Phenacodus primaevus*, the typical specimen. From the Lower Eocene of Wyoming, Big Horn Mountains.

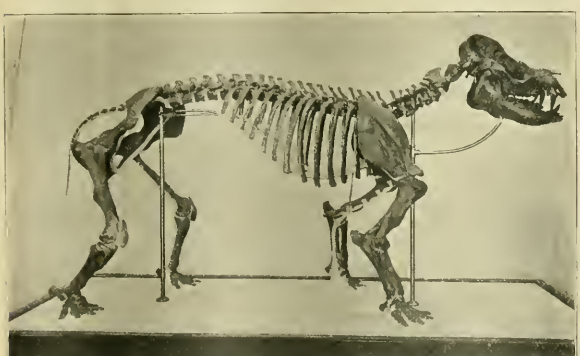


FIG. 3.—*Coryphodon testis*, skeleton of a large male. From the Lower Eocene of Wyoming, Big Horn Mountains.

and thus the two-fold impression of age and of fossilisation is at once given.

These reliefs, however, have the disadvantage of practically burying one side of the animal, and thus rendering many parts both immovable and difficult of access for purposes of study. In other words, the exhibition purpose too far supersedes the purely scientific and research purpose. An entire departure was therefore made in the skeletons of the swimming rhinoceros, *Metamynodon* ,and of the great Titanotherium, both from the Oligocene.

A word will be of interest in regard to the discovery of these animals. The first remains of the Metamynodon were secured in 1892, namely, the skull and jaws and the greater part of the skeleton. A vigorous search in 1894 supplemented these parts by a complete left hind foot and an almost complete right fore foot. Bones of this animal are extremely rare, and the only pelvis which could be found belonged to an individual of slightly smaller size. With these materials, however, a complete skeleton was made up, and it shows clearly the many wide contrasts between this animal and the true rhinoceros. The animal in life was over nine feet long, and about five feet high, with habits rather like those of the hippopotamus than rhinoceros. In the same year, 1892, the fortunate discovery was made of a magnificent Titanotherium skeleton in South Dakota. The skull was first found in a somewhat fragmentary condition, and then the neck, entire trunk and fore limb, perfect even to the sesamoids, were excavated as far back as the last lumbar vertebra and the border of one ilium. At this point there was a great disappointment—the party encountered a sudden change in the rock, and found that the sacrum, the remainder of the hip and hind limbs had been carried away by an erosion which had probably occurred at some time after the original deposition of the entire animal It required the work of two parties during the season of 1894 to secure the bones of the hind quarters of proper proportion belonging to the same species. The mounting method adopted, as fairly shown in the photograph (Fig. 2) consists in carrying steel rods upon the inner sides of the limbs and arches, to connect with a main rod

which passes through the neural canal, this in turn being supported by two heavy uprights. The weight of this skeleton is enormous, yet it can be moved about without the least danger. It is perfectly rigid, and every part can be freely reached for purposes of study. As completed it stands about 14 feet long, 8 feet high, and 4 feet broad.

Another skeleton, mounted by a substantially similar method, belongs to the very rare animal *Coryphodon* (Fig. 3). This was also laboriously brought together after three separate expeditions to New Mexico and Wyoming, the complete remains being finally found upon a level in the Bad Lands adjoining the Big Horn River in northern Wyoming. It represents a number of different individuals, but there is no question that the remains belong to one species, and are of a fully adult type. In general one is struck with the very large size of the head, upon which can be seen swellings prophetic of the posterior horns of Uintatherium, the formidable tusks, heavy girdles, powerful fore limb bent out at the elbow, and a semi-plantigrade or subdigitigrade step. Other peculiar features are the shortness of the spines and the shortness of the ribs. It is shown that Coryphodon had a very short back, spreading limbs, and a very clumsy shuffling gait.

A decided advance upon this method was made in the remounting of the famous skeleton of Phenacodus procured with the Cope direction. It had been mounted under Prof. Cope's collection as found, laterally crushed, a large portion of the vertebræ and ribs concealed, so that their number could not be definitely ascertained, and in such position as to convey a false impression both of the proportions and mode of locomotion of this remarkably primitive ungulate. After very careful deliberation, it was decided to remove the skeleton entirely from the matrix, and remount it as nearly as possible in the natural position. This removal cost many months of labour, and two months more were occupied by Mr. Hermann, preparator, in setting up the animal as represented in the photograph (Fig. 4). In the course of the removal of the stone and plaster matrix the two missing cervical vertebræ were found inserted in the tail, and the number of ribs was definitely ascertained to be fifteen on each side, thus positively determining the dorsal vertebral formula—a matter of very great importance. These results alone justified the labour and expense involved, and the mount is now a model of its kind, since it not only displays the real anatomical character and natural position of the animal, but every bone on one side of the body or the other can be removed for purposes of detailed study. It strikes us as a rather slenderly built, straight-limbed animal, digitigrade like the tapir, five-toed, but almost exclusively supported upon three toes. Sir William Flower's restoration, in his volume upon the Horse, is very nearly correct; the upwardly arched back, powerful lumbar vertebræ, long hind quarters and long powerful tail, when contrasted with the much shorter fore quarters, rather low withers and small head, are all reminiscent of the clawed ancestry of this hoofed animal.

Of much more recent age is the skeleton of *Teleoceras*

Fig. 5.—*Teleoceras fossiger*, female rhinoceros with a small terminal nasal horn. From the Upper Miocene of Nother Kansas.

fossiger, a feebly horned rhinoceros living in great numbers at the top of the Miocene. This animal represents an aged female, of very large size, mounted from materials belonging to probably twenty individuals,

which were secured in Northern Kansas in the autumn of 1894 (Fig. 5). It comes from the famous quarry which has supplied several museums with more or less complete collections. From various accounts, and especially from our own observations, it appears that this quarry represents an old bone bed, probably the deposit of some stream or small river, along which the rhinoceroses herded in great numbers. Our party secured here over 400 complete bones, representing mingled remains of both sexes and of all sizes. Only in certain spots was the proximity of one specimen to another found to be a proof of association. By careful study of such occasional associations and selection of bones representing only the largest and oldest individuals, a skeleton was gradually brought together, which is believed to represent very nearly the correct proportions of this exceptional type. The dimensions are: length, 10 feet 2 inches; height at withers, 4 feet 1 inch; and greatest girth, 9 feet 2 inches. It thus appears that from head to tail *Teleoceras fossiger* was only six inches shorter than *Rhinoceros unicornis*, while the back is 18 inches nearer the ground. This remarkable lowering of the trunk is chiefly caused by the great reduction of the fore-arm, fore-leg, and metapodials. The abdominal girth exceeds that of the Indian rhinoceros, justifying Cope's assertion that this animal had rather the proportions of the hippopotamus than of the existing rhinoceros. Osborn and Scott undertook a restoration of the skeleton of this animal in 1890, but did not venture to give the ribs their full length, as they far exceeded those of any existing form. The length of rib as here shown is, however, beyond question. By comparison of this mount with those preceding, it will be seen that it presents a very marked advance in the method of mechanical construction. The only visible supports are the vertical uprights and the horizontal pieces holding the ribs. All the remaining supports are of steel, and consist of rods which traverse the centre of the various bones, even of the delicately arched ribs, and are thus entirely concealed. This method, which appears to be the most perfect of its kind, would be, however, impracticable in skeletons coming from the older Eocene rocks, which are composed of very much denser material.

Altogether there are now thirteen mounted skeletons exhibited in the Museum, and fifteen others are in various stages of preparation.

HENRY F. OSBORN.

NOTES.

WE have been asked by Prof. Meldola, the Hon. Organising Secretary to the Sylvester Memorial, to state that this Fund has now been closed, the subscriptions amounting altogether to over 890*l*. The capital sum has been invested by Lord Rothschild, the Treasurer of the Fund, on behalf of the subscribers, and the dividends will be transmitted to the Treasurer of the Royal Society. The engraving of the dies has been entrusted to Mr. John Pinches, and it has been decided that the material of the medal shall be bronze, that the award shall be triennial and irrespective of nationality, and that the recipient of the medal shall receive the accumulated (triennial) interest of the Fund, after deducting the cost of striking the medal. An autotype print of the medal will be presented to the subscribers by Prof. J. M. Peirce (of Harvard University) as soon as the dies have been engraved.

THE Geological Society of London will this year award its medals and funds as follows:—The Wollaston Medal to Prof. Charles Lapworth; the Murchison Medal to Mr B. N. Peach, and a second Murchison Medal to Mr. John Horne; the Lyell Medal to Lieut.-General C. A. McMahon; the Bigsby Medal to Prof. T. W. Edgeworth David; the Wollaston Fund to Prof. J. B. Harrison; the Murchison Fund to Mr. James Bennie; the Lyell Fund is divided between Mr. Frederick Chapman and Mr. John Ward.

THE Institution of Electrical Engineers has made the following awards for papers read during the session 1897–98:—The Institution Premium to Mr. Horace F. Parshall, for his paper on earth returns for electric tramways. The Paris Electrical Exhibition Premium to Mr. Robert Hammond for his paper on the cost of generation and distribution of electrical energy. The Fahie Premium was not awarded because no telegraphic or telephonic papers had been read during the session. Extra Premium to Mr. Leonard Andrews, for his paper on the prevention of interruptions to electricity supply. Premium for original communications, to Mr. H. N. Allen, for his paper on sparkless reversal in dynamos. Students Premiums were awarded to Mr. J. M. Donaldson for his paper on the Dover electric tramways; Mr. Maurice Solomon, for his paper on Hertz waves and wireless telegraphy; and Mr. E. E. Tasker, for his paper on alternate current motors. Salomons Scholarships were awarded to Mr. Tom Rolls Renfree, King's College, London, and Mr. H. J. Tomlinson, University College, London.

A SHORT account of the recent celebration of the centenary of the St. Petersburg Military Medical Academy is given in the current number of the *Lancet*. The celebration commenced on December 30, 1898, when the congratulatory addresses of the presidents were presented. On Sunday, January 1, a visit was paid to the large non-military hospital associated with the Imperial Academy and to the Physical Laboratory, over which the delegates were shown by Dr. Danilevsky, who exhibited many experiments with liquid air, and demonstrated an apparatus by Zeiss by means of which images of small opaque bodies could be perfectly reproduced upon the lecturer's blackboard or screen. The chief part of Monday, January 2, was spent in a tour of inspection through the immense establishment on the islands at which all the instruments, splints, dressings, and apparatus are made for the army. On Wednesday, January 4, a miniature review was held by the Czar in an enormous riding school, and on its conclusion the delegates had the honour of being presented one by one to his Imperial Majesty. The British representatives were Rev. H. S. Cronin, Mr. Cross, Dr. Ferguson, Prof. Ogston, Mr. Owen, and Prof. Shipley. Throughout the entire series of functions the Minister of War showed by his presence that he deemed the Army Medical Department of real importance to his country. He expressed considerable pleasure at receiving congratulatory remarks from his visitors. It evidently gave him particular satisfaction to read out at the banquet before 500 guests a congratulatory telegram which arrived from the German Emperor.

THE *Lancet* states that on the occasion of the recent jubilee of the St. Petersburg Academy of Medicine, the following British men of science have been appointed honorary members of the Academy:—Sir William MacCormac, Bart.; Sir William Turner, Lord Rayleigh, Sir William Stokes, Dr. William MacEwen, and Drs. Thompson and Lauder Brunton.

PROF. CHANTEMESSE, of the Pasteur Institute, Paris, has been promoted to the grade of Officer of the Legion of Honour.

PROF. ALEXANDER G. R. FOULERTON has been appointed bacteriologist to the Middlesex Hospital.

PROF. POINCARÉ has been nominated president of the French Bureau des longitudes, M. Faye, vice-president, and Prof. Lippmann, secretary.

MR. J. G. BAKER, F.R.S., has retired from the post of curator of the Herbarium at Kew, in which he is succeeded by Mr. W. Botting Hemsley, F.R.S.

PROF. G. H. DARWIN, F.R.S., has been nominated president of the Royal Astronomical Society, for election at the annual meeting on February 10. Mr. F. W. Dyson has been nominated to succeed Prof. Turner as secretary.

WITH a view to encourage inoculation among its servants, the Madras Government has authorised the grant of three days' casual leave on full pay to those inoculated. The operation is purely voluntary. Similar concessions are granted to those attending the Government and aided schools.

IT is reported that an extraordinary long-distance telephone test has been made at Little Rock, Arkansas, by President Chas. J. Glidden, of the South-Western Telegraph and Telephone Company, who held a conversation over the wire with a Boston friend. The distance from Little Rock to Boston is 1900 miles.

THE Automobile Club de France announces a competition for motor-car accumulators, to take place in Paris in April next. Tests will be made on the life of the cells, and on their useful efficiency; and account will be taken of the "frequency, importance, and facility of operations for maintenance," and of the weight of the cells.

WE learn from *Science* that Prof. G. W. Farlow, of Harvard University, has been elected president of the American Society of Naturalists; Prof. R. S. Woodward, of Columbia University, has been elected president of the American Mathematical Society, in succession to Prof. Simon Newcomb; and Prof. John Dewey, of the University of Chicago, has been elected president of the American Psychological Association.

REUTER reports that the eruption of Vesuvius on January 15 attained great proportions, the flow of lava being greater than any which has hitherto occurred. Streams of lava are flowing down the mountain side, one passing near the observatory and another going in the direction of the lower station of the funicular railway.

THE death is announced of Dr. Constantine Vousakis, professor of physiology in the University of Athens.

THE death is announced of Brigade-Surgeon Lieut.-Colonel Robert Pringle, late of the Indian army. Lieut.-Colonel Pringle was for many years attached to the sanitary department of the North-West Provinces and Oudh, and took a keen interest in all problems connected with public health, especially in relation to India. He was the author of numerous papers and pamphlets contributed to medical journals, the Society of Arts, sanitary conferences, and other places.

THE death of Prof. Wilhelm Dames, professor of geology and palæontology at the University of Berlin, in his fifty-sixth year, is announced in the *Athenaeum*. He was a pupil of Beyrich, and succeeded him in 1896 as director of the geological-palæontological collection. Amongst his many scientific publications, his studies upon fossil fishes stand in the foreground. Since 1883 he had been the co-editor with E. Kayser of the Berlin *Paläontologische Abhandlungen*.

DR. GOTTLIEB GLUGE, Emeritus professor of physiology and anatomy in the University of Brussels, has (says the *Lancet*) died at Nice, aged eighty-six years, having been born in Westphalia in 1812. While a student in Berlin he worked with Froriep, who was prosector at the Charité, and discovered the oil globules in cells undergoing fatty degeneration. After a period of study in Paris he published an important paper on influenza treated historically and pathologically, for which he was awarded a prize by the Berlin Medical Faculty. In 1838 he was appointed professor of physiology in Brussels. His "Atlas of Pathological Anatomy" appeared in parts from 1843 to 1850. For the last twenty-three years he had been living in retirement.

The *Times* correspondent at Washington states that Prof. Worcester, of Michigan University, has been asked to be a member of the commission which President McKinley will send to the Philippines. It is understood that the commission will study the manners and habits of the Filipinos, the material resources of the country, and its commercial possibilities, but will not attempt to deal with the problem of its government. Dr. Schurman, president of Cornell University, will be president of the commission, which is expected to sail about February 1.

AN abstract of a report on the mineral resources of the Philippine Islands, sent by Dr. George F. Becker to the U.S. Geological Survey, is published in *Science*. Dr. Becker says that, so far as is definitely known, the coal of the Philippine Islands is all of the Tertiary age, and might better be characterised as a highly carbonised lignite. Lignite is widely distributed in the archipelago; some of the seams are of excellent width, and the quality of certain of them is high for fuel in this class. Coal exists in various provinces of the Island of Luzon, and a number of concessions for mining have been granted. Many of the other islands contain coal, and in the great Island of Mindanao it is known to occur at eight different localities. In the Island of Cebu petroleum has been found associated with coal at Toledo, on the west coast, where a concession has been granted. It is also reported from Asturias, to the north of Toledo on the same coast, and from Alegria to the south. Natural gas is said to exist in the Cebu coal fields. On Panay, too, oil is reported at Janinay, in the province of Iloilo, and gas is reported from the same island. Petroleum highly charged with paraffin is also found on Leyte at a point about four miles from Villaba, a town on the west coast. Gold is found at a vast number of localities in the archipelago, from northern Luzon to central Mindanao. In most cases the gold is detrital, and is found either in existing water-courses, or in stream deposits now deserted by the current. Copper ores are reported from a great number of localities in the Philippines. A lead mine has been partially developed near the town of Cebu, and there is iron ore in abundance in Luzon, Caraballo, Cebu, Panay, and doubtless in other islands. Sulphur deposits abound about active and extinct volcanoes in the Philippines.

A REUTER correspondent at Cadiz reports that the coffin containing the remains of Christopher Columbus has been opened. It was found to contain about thirty bones and some ashes. The coffin was then closed again and conveyed on board the despatch boat *Giralda*, which was to leave on Wednesday for Seville, where the remains of Columbus will be received with great ceremony and deposited in the cathedral.

THE prize awards of the Paris Academy of Medicine are announced in the *British Medical Journal*. This year, as usual, the most noteworthy features were the decisions of the Academy as to the Audiffred, Laborie, Chevillon, and Adrien Buisson prizes. Two years ago Madame Audiffred gave a capital sum, estimated to produce an income of 2400 francs (960*l*.), to be awarded as a prize to any one who shall discover a means of curing or preventing tuberculosis. Among the serious workers who competed, special mention is made of Dr. Auclair, of Paris, who has made interesting researches on the substances extracted from the tubercle bacillus, and has shown that the fatty matters contained in excess in the bacillus are necrosing agents, and doubtless play a part in the resistance of the bacilli to phagocytosis. A sum of 80*l*. was awarded to him by way of encouragement, while 20*l*. was given on the same

ground to Drs. Auché and Hobbs of Bordeaux. The Laborie prize (200*l.*), for the best work in surgery, was divided between MM. Poncet and Bérard of Lyons. The Chevillon prize of 60*l.* is given for the best work on the treatment of cancerous diseases. This year a portion of it (40*l.*) was awarded to Drs. A. Guinard and Livet, who have used carbonate of calcium as a local application with considerable success as far as the relief of pain and the arrest of hæmorrhage and the prevention of fœter are concerned. The Buisson prize consists of a sum of 420*l.*, awarded triennially to the discoverer of methods of curing diseases regarded as incurable. This year there were only three competitors: Dr. Frenkel, who propounded a method of training whereby ataxic patients may be drilled into the recovery of muscular coordination; Dr. Jayle, who has made a series of investigations as to the practical utility of ovarian extract in the treatment of nervous and circulatory disorders accompanying dysmenorrhœa and the menopause, whether natural or artificial; and Dr. Petit, who presented a thesis on tuberculosis of the glands of the neck. The Academy did not see its way to award the prize, but gave 40*l.* each to Dr. Frenkel and Dr. Jayle, and 20*l.* to Dr. Petit by way of encouragement.

THE performances of the submarine vessel, *Gustave Zédé*, appear to have given much satisfaction to naval experts on the other side of the Channel, though our own engineering papers are by no means impressed by the experiments. We learn from the *Times* that the semi-official *Moniteur de la Flotte*, commenting upon the trials of the *Gustave Zédé*, says that at length, after twelve years of continued efforts, the problem has been solved. The *Gustave Zédé*, unassisted, has steamed from Toulon to the Salins d'Hyères and to Marseilles, sometimes on the surface and sometimes submerged, and has successfully discharged her missiles at the mark. On the surface she is almost invisible, and presents a target scarcely capable of being hit; below water her presence is revealed neither by the noise of her engine nor any movement of the surface. The objection raised against the submarine boat that she is blind loses force, since the *Gustave Zédé* makes momentary appearances on the surface to redirect her course, while she has a telescopic tube, with an arrangement of prisms and mirrors, utilising the principle of the *camera obscura*, which permits the surroundings to be surveyed, though imperfectly, in case of emergency. The *Gustave Zédé* has a restricted range, owing to the great weight of the electric accumulators; but the new boats of the Narval class will have auxiliary steam for surface navigation.

SOME interesting particulars with reference to the White Star liner *Oceanic*, which was successfully launched from the Belfast ship-yard of Messrs. Harland and Wolff at the end of last week, and is the longest and heaviest ship yet projected from a slipway, are given in *Engineering* of January 13. The following table shows how the new vessel compares with others:—

Steamer's name.	Date.	Moulded dimensions.						Draught.		Displacement.
		Length.		Breadth		Depth.				
		ft.	in.	ft.	in.	ft.	in	ft.	in.	
Great Eastern	1858	680	0	83	0	57	6	25	6	27,000
Britannic	1874	455	0	45	0	36	0	23	6	8,500
Arizona	1879	450	0	45	2	37	6	22	0	—
Servia	1881	515	0	52	0	40	6	23	3	9,900
Alaska	1881	500	0	50	0	39	8	22	0	—
City of Rome ...	1881	542	6	52	0	38	9	22	0	11,230
Oregon	1883	500	0	51	0	40	0	23	0	—
Paris	1888	527	6	63	0	41	10	23	0	13,000
Teutonic	1890	565	0	57	6	42	2	22	0	12,000
Campania ...	1893	600	0	65	0	41	6	23	0	—
Kaiser Wilhelm der Grosse ...	1897	625	0	66	0	43	0	—		20,000
Oceanic	1899	685	0	68	0	49	0	32	6	28,500

The displacement of 28,500 tons given in the table for the new vessel is that at the load draught, which, as stated, is 32 feet 6 inches. The passenger accommodation of the *Oceanic* will be for 410 first-class passengers, 300 second-class, and 1000 third-class passengers, whilst the officers, crew, and other members of the ship's company will be 394, bringing the total up to 2104 persons.

ON Thursday last (January 12) the whole of the British Islands experienced a storm of unusual violence, which caused much loss of life and damage to property both on land and at sea. The storm was noteworthy because of the suddenness of its appearance and the rapidity with which it travelled, as well as for the area which it covered; for while the centre of the disturbance passed over Scotland, its fury was felt far to the south of the English Channel. On the morning of the previous day the Weather Chart published by the Meteorological Office showed that, although small secondary depressions were crossing our islands from west to east, the symptoms were favourable for an improvement of the recent unsettled weather, and the observations taken at 6h. p.m. on Wednesday showed that the barometer was steady or rising all along the western coasts. The chart for 8h. a.m. of Thursday showed that the barometer had fallen more than half an inch at some stations during the night, and that the northern part of Ireland was already experiencing the full force of the gale that had suddenly set in from the Atlantic; at Belmullet, in the north-west of Ireland, force 12 of the Beaufort wind-scale, or a complete hurricane, was blowing. During the day it rapidly spread to other parts of the country, a heavy south-west gale was blowing in the Channel, with terrific seas, and very heavy gusts and rainfall were experienced in London. By the next morning (Friday) the centre of the disturbance was passing over Germany and the Baltic, the storm area having travelled at the unusually high rate of about thirty-four miles an hour.

AT the Institution of Civil Engineers, on January 10, a paper was read on "High-speed Engines," by Mr. J. H. Dales. In applying provisions for eliminating knock in double-acting engines, Mr. Dales has found that the ordinary rates of rotation can, with practical immunity from overheating, and an absolute freedom from seizure of bearings, be exceeded to the extent of 30 per cent. to 50 per cent. This has been effected by providing a close-up, and at the same time expansible, adjustment of bearing brasses, and so reducing the production of heat to only that caused by the rotation of a shaft as distinguished from the usual cause of seizure—namely, the expansive force of the metal of both journal and brasses.

ON August 15 and September 17, 1897, three earthquakes occurred in Turkestan, which, considering their comparatively slight intensity, were recorded by horizontal and other pendulums over a very wide area, the most distant station being more than 5000 km. from the epicentre. In each case the estimates of the velocity vary greatly, and Dr. Agamennone, who has studied the records, considers that the differences are to be ascribed to the variety of the instruments employed, rather than to any uncertainty in the time-records. It is important to notice that the highest velocities are always given by the Italian pendulums, which therefore appear, in spite of their mechanical system of registration, to be the most sensitive to these disturbances.

THE publication of Cohn's *Beiträge zur Biologie der Pflanzen* will not be discontinued owing to the death of Prof. Cohn. It will still be brought out, as heretofore, at irregular intervals, under the editorship of Prof. O. Brefeld, his successor in the chair of Botany at the University of Breslau.

THE *Botanical Gazette* announces two expeditions for the purpose of discovering food-plants and others of economical

value suitable for introduction into the United States—one by Mr. W. T. Swingle, to the Mediterranean coasts of Europe, Asia, and Africa; the other by Mr. D. G. Fairchild and Mr. B. Lathrop, to both coasts of South America.

THE addition to the British flora of a species belonging to so well-known and conspicuous an order as the Orchideæ, is an unexpected circumstance. Mr. H. Goss has been fortunate enough to accomplish this in the case of *Orchis cruenta*, Muhl., which he has found growing abundantly in several spots in boggy ground at an altitude of about 1000 feet, between Borrowdale and Watendlath, in Cumberland. *O. cruenta* is nearly related to *O. incarnata* and *O. latifolia*, being regarded by some authorities as a variety of the latter. The discovery is especially interesting as adding one more to the small number of specially Arctic plants comprised in our flora. It has hitherto been known only in Norway, Sweden, and Finland. It should be looked for in Scotland.

IN a paper published in the *Annals of Botany* for December, Mr. H. Wager appears to have set at rest the much-disputed question of the presence of a nucleus in yeast-cells. In all the species of *Saccharomyces* examined—*S. Cerevisiae*, *Ludwigii*, *pastorianus*, and *Mycoderma*—he finds what he calls a "nuclear apparatus," that is, a special portion which appears to be set apart to perform the function of a nucleus. This nuclear body is perfectly homogeneous, even when observed under the highest powers of the microscope, and appears to correspond rather with the nucleole of higher plants. One of these bodies is found in every yeast-cell. In addition to the nuclear body, there is in every yeast-cell a structure of the nature of a vacuole, which appears to be an essential part of the nuclear apparatus, and to possess some of the attributes of a nucleus. This structure has often been mistaken for the nucleus itself.

PROF. W. B. CLARK, State Geologist, reports, in the *Johns Hopkins University Circular* for November, on the progress of the Maryland Geological Survey and Maryland Weather Service during the session 1897–98. Established in 1896, the aim of the Survey has been to inaugurate those investigations which would prove most beneficial to the people of the State, and at the same time contribute most largely to the knowledge of the stratigraphy and structure of the country. With the aid of a surveying force provided by the United States Geological Survey, a large area has been surveyed topographically on the scale of an inch to a mile. The geological work is systematically divided, and a competent man placed in charge of each large district. Subjects such as the highways and road-metals, agriculture and soils, distribution of plant and animal life, and terrestrial magnetism are dealt with by officers specially chosen for the purpose. Prof. G. P. Merrill conducted investigations on the building and decorative stones. Statistical data are collected regarding the output of each industry that has to do with the mineral wealth of the State. The Survey, in short, is conducted in a way that reflects the highest credit on the State Geologist. As director of the State Weather Service, he carries on this branch of work in close co-operation with the State Geological Survey, the State Agricultural Institutions, and the United States Department of Agriculture. Reports from the State Weather Service are promised upon the physiography, meteorology, medical climatology, agricultural soils, forestry, hydrography, crop conditions, botany, and zoology of Maryland.

WE have received, from Messrs. J. Elster and H. Geitel, an excerpt paper from *Terrestrial Magnetism* for June last, on a method of determining the direction of vertical electrical currents in the atmosphere by observations of atmospheric electricity. In connection with this subject, we would draw attention to an important article by Mr. W. Trabert in *Meteorologische Zeitschrift* for November last, on the connection between the phenomena of terrestrial magnetism and the electrical processes in the atmosphere, in which special reference is made to the above paper. Messrs. Elster and Geitel have pointed out that the direction of any vertical current from the surface of the earth, induced by a process analogous to electrical dissipation or conduction, is completely determined by the sign of the electricity of the ground, or, what is the same thing, by the sign of the potential over the corresponding locality. Thus if the surface of the earth is everywhere negatively charged, there must be a downward vertical current due to conduction. But they also point out that cases are imaginable in which the conveyance of electricity occurs in the opposite direction, and must be traced to some other process, either mechanical or one which is at present quite unknown. It may possibly be due to the effects of terrestrial magnetism, and be detected by measurements of atmospheric electricity.

AN elaborate series of tests on cadmium standard cells has been undertaken by Mr. S. N. Taylor (*Physical Review*, vol. vii. pp. 149–170, 1898). The ratio of the E.M.F. of the Clark cell (15° C.) to the Cadmium cell (21·7°) is given as 1·4077; this may be compared with the Reichsanstalt determination, 1·4063, and with the recently published value, 1·40663, of Jaeger and Kahle, *Zeitschr. fiir. Instrk.*, June 1898. Assuming that the E.M.F. of the Clark cell is 1·433 volts, the Cadmium cell has an E.M.F. of 1·0180 volts. But the value of the Clark cell is not definitely established to the third decimal place; its E.M.F. is variously stated as follows:—Rayleigh, 1885, 1·4345; Carhart, 1·434; Glazebrook and Skinner, 1892, 1·4342; Kahle, 1896, 1·4322.

THE new issue of *Natural Science*, which has lately changed hands, differs little from the numbers with which we have for some years been familiar. The original communications include the Friday evening address delivered by Prof. W. J. Sollas before the British Association at Bristol, on "Funafuti: the Study of a Coral Atoll." Mr. T. J. Cunningham discusses in detail Prof. Weldon's evidence of the operation of natural selection, expressed in the presidential address before the section of biology at the same meeting of the Association. Mr. H. C. Wyld writes on biological analogy and speech development, and Dr. A. T. Masterman contributes an article upon the subject of symmetry of organisms. In addition to these articles, there are the usual critical notes and comments, reviews, a budget of fresh facts, and items of news.

THE *Transactions* of the Leicester Literary and Philosophical Society, New Series, vol. v. Parts 1 and 2 (July and October, 1898), contain the following papers on entomology: "A Group of Insects' Home-made Cradles," by G. B. Dixon; "Notes on the British Longicornes," by Horace Donisthorpe; "On the Genera Depressaria and Gelechia," by Rev. Canon Cruttwell; and "On the Evolution of the Hind Wing in Lepidoptera," by W. J. Kaye. The *Proceedings* of the Sections include numerous shorter notes on various branches of natural history, though entomology seems to receive the lion's share of the attention of the naturalists belonging to this energetic local society.

BOUND in a strong handsome cover, and containing excellent illustrations from beginning to end, volume ix. of the *Practical Photographer* (Percy Lund, Humphries, and Co., Ltd., London) consists of the issues for the past twelve months, and forms a volume which every amateur photographer would like to possess. Among the numerous articles will be found interesting criticisms of the pictures exhibited at the various photographic exhibitions held during the year, practical notes on the different branches of the art, descriptions of the styles of work, and illus-

trations of pictures taken by some of the more well-known photographers, and many other subjects too numerous to mention, but which are of practical use to the amateur. Great pains have apparently been taken to ensure the successful reproductions of the pictures included in the 370 pages which compose this volume, and a perusal of even these alone may give hints to many amateurs on the somewhat difficult tasks of lighting, pose, &c.

THE additions to the Zoological Society's Gardens during the past week include a Gazelle (*Gazella dorcas*, ♀) from Egypt, presented by Mr. J. S. N. Allison; a White-cheeked Hill Partridge (*Arboricola atrigularis*) from the Naga Hills, Assam, presented by Mr. K. S. Cassells; a Regent Bird (*Sericulus melinus*, ♂) from Australia, a Weka Rail (*Ocydromus australis*) from New Zealand, a Black-headed Lemur (*Lemur brunneus*), bred in the Gardens, deposited; two Gluttons (*Gulo luscus*, ♂ ♀) from Northern Europe, a Common Otter (*Lutra vulgaris*), British; three Australian Rails (*Rallus pectoralis*), two White-cheeked Honey-eaters (*Meliphaga sericea*) from Australia, a Red Ground Dove (*Geotrygon montana*) from South America, purchased.

OUR ASTRONOMICAL COLUMN.

COMET CHASE.—This comet, which is now about as bright as it was at the time of its discovery last year, has the following ephemeris for the current week :—

Berlin Midnight.

1899.	R.A. (app.). h. m. s.	Dec. (app.).
Jan. 21	11 9 55	+32 27·7
23	9 55	32 50·7
25	9 48	33 13·4
27	9 35	33 35·9
29	11 9 16	+33 57·9

VELOCITY IN THE LINE OF SIGHT OF η PEGASI.—In a previous number of the *Astrophysical Journal* (vol. viii. No. 3), Prof. Campbell pointed out that his observations had indicated that the motion in the line of sight of the star η Pegasi (R.A. 22h. 38·2m., Dec. + 29° 41′·2, mag. 3·1) is variable. Writing in the *Astronomische Nachrichten* (No. 3536), Herr Belopolsky tells us that he is able to corroborate this statement from observations made by him at the Pulkova Observatory. The following are the results of his measures of this star, the number in the last two columns representing the velocities per second in geographical miles, in relation to the earth and sun respectively.

	Motion relative to Earth	Sun.
1897 Aug. 27	−1·70	−0·66
Sept. 8	−1·03	−0·64
1898 Aug. 25	+1·27	+2·29
Sept. 17	+3·05	+2·26

The mean of Belopolsky's values for the two years thus reduce to −4·8 and +16·9 kilometres per second, while those of Campbell for 1897 July–September and 1898 August–September, are given as −4·3 and +16·2 kilometres per second. These values it will be noticed agree well with one another, and indicate further the accuracy that can now be obtained in such measures.

THE LEONIDS IN 1898.—In the December number of the *Monthly Notices* there are several communications on the meteors seen in November last, to which we have not yet drawn our readers' attention. At the Cape Observatory, Dr. Gill had made special provision for obtaining both eye observations and photographs on the nights of the 13th and 14th.

For the latter work, five cameras were arranged to cover the region round the radiant point, while a Cooke doublet was directed towards the radiant. All the cameras were fixed to equatorials, and the plates changed every hour. No photographic results were obtained, and, indeed, the eye observations indicated that the shower was nothing out of the ordinary. No more fortunate was Dr. Copeland, who, with some assistants, watched on the nights of the 13th to 15th. At Cambridge, Mr. Hinks, who with several other observers kept their vigil during the same three evenings until dawn, and were perhaps a little more fortunate on the 14th, when from 11h. to 18h. thirty-two Leonids were seen.

The shower seems, however, to have been better seen in America, as will be gathered from the following extracts of a letter from Prof. Barnard to Dr. Johnstone Stoney. Prof. Barnard watched on the nights of the 11th–16th, between the hours 5 p.m.–6 a.m.

He writes :—"The sky cleared shortly after midnight on the 14th. I soon saw there were a few meteors, but not noticeable, which could be traced back to the radiant, though they were mostly low in the north-west, near α Cygni. They became more frequent, and some large ones were seen. From this till daylight several hundreds were seen—many of the first magnitude, and a few brighter. Very few were seen near the radiant, and none at it." As regards the time of greatest frequency of the meteors, Prof. Barnard says :—"It seemed to me the maximum was reached between 3 and 4 a.m., perhaps nearer 4. It was the finest display of meteors I have yet seen."

On the 16th and 17th, not a single Leonid was observed by Prof. Barnard. Five cameras were employed to record the trails, but the development of the least promising of them has given no trails.

NEW INSTRUMENT FOR MEASURING ASTROGRAPHIC PLATES.—Now that photography is so largely used for obtaining charts of the stars, several styles of measuring instruments have been devised to obtain directly the coordinates of the star discs from the negatives. The great difficulty in designing such instruments is that simplicity of construction, accuracy of measurement, and rapidity of working must be well combined. The most recent form is that which we owe to Dr. Gill, and which will be found fully described and illustrated in the *Monthly Notices of the R.A.S.* (vol. lix. No 2). While taking advantage of the rapidity of Prof. Turner's method, Dr. Gill has retained the accuracy which is attainable with the filar micrometer. The result, as Dr. Gill states, has fully realised his expectations, "thanks to the artistic skill and care of Messrs. Repsold, to whom I entrusted the carrying out of my plans." The whole process of measurement is "so simple that an observer without any previous knowledge or experience in practical work of the kind can, after very short training, easily measure the two coordinates of eighty stars per hour (including diameters); and were it not that the observers are instructed to work very carefully, a larger number could be measured in the same time."

THE SPECTRUM OF THE CORONA.[1]

THE announcement by Prof. Nasini of the possible presence of the characteristic green line of the corona in the spectrum of the gases collected at the Solfatara of Pozzuoli (NATURE, vol. lviii. p. 269, July 21, 1898) renders it desirable that I should at once publish some of the results of an investigation relating to the spectrum of the corona with which I have lately been occupied.

In the course of my early observations of the spectrum of the chromosphere, I discovered on June 6, 1869, a bright line at 1474 on Kirchhoff's scale, which I stated to be coincident with a line of iron (*Roy. Soc. Proc.*, vol. 18, p. 76).

During the total eclipse of the sun on August 7, 1869, a green line was recognised by Prof. Young as belonging to the spectrum of the corona, and the position of this line was also stated to be 1474K.

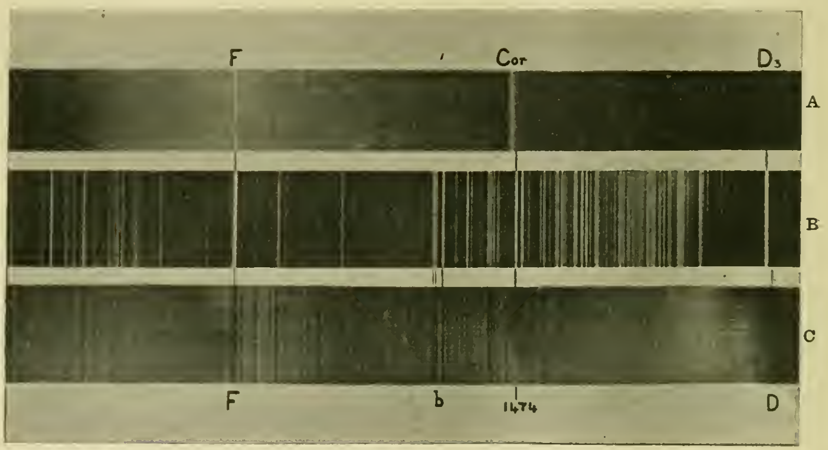
Although other determinations of the position of the green line of the corona during eclipses have not all agreed absolutely with Young's observations, the differences have been attributed to errors of observation, so that Young's statement of the coincidence of the coronal and chromospheric lines, and their correspondence with the solar dark line at 1474K has been generally accepted. No special attention appears to have been directed of late years to the measurement of the corona line itself.

This and other coronal radiations were photographed as rings by the use of prismatic cameras in 1893, 1896, and 1898, but a full list of them has only so far been published for the photo-

[1] Paper read before the Royal Society on November 24, by Sir Norman Lockyer, K.C.B., F.R.S.

graphs taken by Mr. Fowler during the eclipse of 1893 (*Phil. Trans.*, A, vol. 187, p. 593). Among the brightest of these rings, which is common to all three sets of photographs, is one about wave-length 4231, which probably is identical with the corona line photographed by Schuster in 1886, and stated to have a wave-length of 4232·8 on Angstrom's scale (4233·4 Rowland). Schuster stated that this line was "probably the same line as 4233·0 often observed by Young in the chromosphere" (*Phil. Trans.*, A, vol. 180, p. 341). The chromospheric line at this wave-length has since been identified as an enhanced line of iron, of which the precise wave-length is 4233·3. Captain Hills photographed this corona line with a slit spectroscope in the last eclipse, and he gives its wave-length as 4233·5 (*Roy. Soc. Proc.*, vol. 64, p. 54), which within the limits of error might be considered coincident with the enhanced line of iron.

The later researches on the spectrum of iron have shown that the iron line which I observed in 1869 to be coincident with the bright chromospheric line at 1474K (5316·79 Rowland) is also an enhanced line, agreeing absolutely with Young's latest determination of the wave-length of the 1474 chromospheric line (Scheiner's "Astronomical Spectroscopy," Frost's translation, p. 425), with which, according to his eclipse observations, the green line of the corona is coincident.



Comparison of the position of the chief line in the spectrum of the corona (A) with the enhanced line of iron at 1474K, seen in the spectrum of the chromosphere (B) and in the ordinary solar spectrum C.

According to these results then, two of the chief lines in the spectrum of the corona would be coincident with enhanced lines of iron. The remaining corona lines which have so far been measured, are not, however, coincident with enhanced lines. It did not seem possible, therefore, that two of the enhanced lines of iron should be present without the others, even if it be admitted that the corona may have a temperature high enough to produce any enhanced lines.

It appeared then, either that the coincidences of the chromospheric and coronal lines about 423 and 531 were accidental, or that they were not real coincidences at all. A careful examination of the eclipse photographs of 1896, taken by Mr. Shackleton, and those of 1898, taken by Mr. Fowler, has therefore been undertaken, with special reference to this point.

The wave-length of the coronal ring at 4231, already published in case of the 1893 photographs, has been confirmed.

The 1896 and 1898 photographs further indicate that the corona line near 4231 is not coincident with the chromospheric line to which reference has been made, and show that while the chromospheric line is coincident with the enhanced line of iron at λ4233·3, the corona line has a wave-length of 4231·3.

With regard to the ring in the green, the lack of sufficient photographs on isochromatic plates in 1893 does not permit of a final determination of wave-length. Important data, however, were obtained, both in 1896 and 1898. A measurement of the position of the chief ring in the green, as shown in these photographs, comparing the ring with the spectrum of the chromosphere and a solar and iron spectrum taken by the same prisms, shows beyond all question that the wave-length is very different from that generally accepted. The mean result of measurements of different parts of the ring made by Messrs. Fowler and Shackleton and Dr. Lockyer is 5303·7, or about 13 tenth-metres more refrangible than 1474K (5316·79).

Although the new wave-length is not to be regarded as final, for the reason that the conditions under which the photographs were taken necessitate certain small corrections which have not yet been fully worked out, it is not likely that it can be in error by so much as 1 tenth-metre.

The examination of the photographs, which has been undertaken in the first instance by Mr. Fowler, indicates that other important conclusions are to be drawn from the admirable series obtained by him, among them the possible existence of one or more new gases, some of the lines of which, as gathered from the dispersions as yet available, appearing also in the spectra of some stars and planetary nebulæ.

The photograph which accompanies this paper has been prepared by Mr. Fowler.

HIGH VACUA PRODUCED BY LIQUID HYDROGEN.[1]

AS an illustration of the extraordinary power of the new cooling agent—liquid hydrogen, the extreme rapidity with which high vacuo can be produced by its use is, perhaps, one of the most striking. The absolute boiling points of hydrogen, oxygen, and chlorine are respectively 35, 90 and 240, in other words oxygen boils at a temperature two and a half times higher than liquid hydrogen, and liquid chlorine similarly at two and a half times that of liquid oxygen. From this we infer that liquid hydrogen as a cooling agent ought to be relative to liquid air as effective as the latter is compared to that of liquid chlorine. Now chlorine at the temperature of boiling oxygen is a hard solid, some 80° below its melting point, and in this condition has an excessively feeble vapour pressure.

[1] "Application of Liquid Hydrogen to the Production of High Vacua, together with their Spectroscopic Examination." Paper read at the Royal Society on December 15, 1898, by James Dewar, F.R.S.

When liquid hydrogen freezes air out of a sealed tube by immersing the end in the liquid, it is to be inferred that no measurable pressure of air ought to be left in the vessel. If we apply Van der Waals's law of corresponding temperatures to the case of hydrogen, the above inference is made unimpeachable. An approach to some knowledge of what the tension of air must be about the boiling point of hydrogen can be attained by exterpolating the vapour pressure curves of oxygen and nitrogen. Taking the following range of boiling point temperatures for nitrogen and oxygen, viz. from the critical point to the boiling point under diminished pressure, two Willard Gibbs formulæ were calculated, with the following results:—

Nitrogen ...	Temp. abs.	127°	78·6°	59°
	Pressure in mm. ...	25,900	740	26

$$\text{Nitrogen.} \quad \log_{10} p = 11\cdot5561 - \frac{400\cdot02}{T} - 1\cdot8980 \log_{10} T \quad \ldots(1).$$

Oxygen ...	Temp. abs..........	154°	90·3°	61·3°
	Pressure in mm...	37,592	740	7·5

$$\text{Oxygen.} \ldots \quad \log_{10} p = 9\cdot4699 - \frac{422\cdot22}{T} - 0\cdot9843 \log_{10} T \ldots(2).$$

Another Gibbs formula was calculated, taking Estreicher's values for the vapour pressure of liquid oxygen below its boiling point, viz.:—

Temp. abs.	91·44°	78·1°	62·8°
Pressure in mm.	743·8	141·8	7·5

$$\text{Oxygen.} \quad \log_{10} p = 16\cdot0670 - \frac{524\cdot72}{T} - 3\cdot8024 \log_{10} T \ldots(3).$$

We deduce from these formulæ the following vapour pressures at the temperature of boiling hydrogen:—

(1) Nitrogen	...	0·0015	Pressure in mm., 35° abs.
(2) Oxygen	...	0·000076	do.
(3) ,,	...	0·000016	do.

The results of calculation, taking the formulæ for the widest range of pressures, viz. (1) and (2), may probably be the surest, but in any case those values must be taken as a *maximum*, seeing they refer to the liquid state, while both oxygen and nitrogen, at the temperature of 35° absolute, are hard solids, and must therefore have dropped to lower tensions than that of the exterpolated liquid vapour pressure curves. It is curious to note that at this low temperature the theoretical ratio of the tensions of nitrogen and oxygen is as 20 to 1. Direct measurements of the vapour pressure of nitrogen at the melting point, or 60° absolute, gave the value of 26 mm., and a ratio of the tensions of nitrogen to oxygen of 6 to 1, whereas from the curves the value ought to be 6·7 to 1. Olszewski gives the tension of nitrogen at − 214° as 60 mm., and as at this temperature the oxygen tension is 3·8 mm., the ratio of the saturated pressures of the two gases at the melting point of nitrogen would be as 16 to 1, which is far too high. Probably the oxygen value will be nearest the truth, seeing it has the lowest melting point. The tension is about a ten millionth of an atmosphere. In the case of nitrogen, the maximum theoretical pressure would be one five hundred-thousandth of an atmosphere. It is safe to infer that the vacuum left after liquefying the air out of a vessel by means of liquid hydrogen cannot exceed the millionth part of the atmospheric pressure, exclusive of the pressure resulting from any incondensable material other than nitrogen and oxygen. This is just about the pressure of the vapour of mercury at the ordinary temperature in the Torricellian vacuum, so that as good an exhaustion ought to result as can be got by boiling out a space with mercury. There is another way in which the question may be put. Assuming the molecular latent heats are approximately proportioned to the absolute boiling points, then we can, from a comparison with the oxygen value, deduce that of hydrogen, and thereby get the constants in a two term formula for the vapour pressures. For pressures below an atmosphere, the following approximate formulæ were deduced:—

$$\text{Oxygen} \ldots\ldots \quad \log p = 7\cdot2058 - \frac{392\cdot6}{T} \text{mm.} \quad \ldots (4).$$

$$\text{Hydrogen} \ldots \quad \log p = 7\cdot2428 - \frac{152\cdot7}{T} \text{mm.} \quad \ldots (5).$$

From these expressions it follows that at its boiling point, or 35° absolute, hydrogen has 7/852000 times the pressure of oxygen, or the latter pressure is about the eight millionth of an atmosphere. A similar formula, calculated from the critical and boiling point data, gives substantially the same order of quantities. Formulæ (4) for oxygen tensions must be fairly accurate, seeing it gives a theoretical latent heat of about 56 units per gram of liquid evaporating at the boiling point, whereas direct determinations result in 55 units. To test this inference, the following plan of experimenting was adopted:—Ordinary shaped vacuum tubes, like A, B, used for the spectroscopic examination of gases, with and without electrodes (Figs. 1 and 2), having a capacity ranging from 15 to 25 c.c., had pieces of quill tubing about a foot long sealed on. The tubes were contracted at D to about 1 mm., so that they could be sealed off with rapidity. The end C sometimes terminated in a small bulb (Fig. 3), in order to give increased cooling surface, and, when necessary, to allow many times the volume of air in A, B, to enter and be condensed with the object of accumulating any incondensable residuum.

The tubes were filled with air, oxygen, and nitrogen at the atmospheric pressure. The liquid hydrogen collected in the vacuum vessel, immersed in another similar vessel full of liquid air, being ready, the end C was dipped in the liquid for a little over a minute, and the tube AB sealed off at D, so that on removal from the hydrogen bath the solid air might melt and distil off without generating any pressure. On attempting to

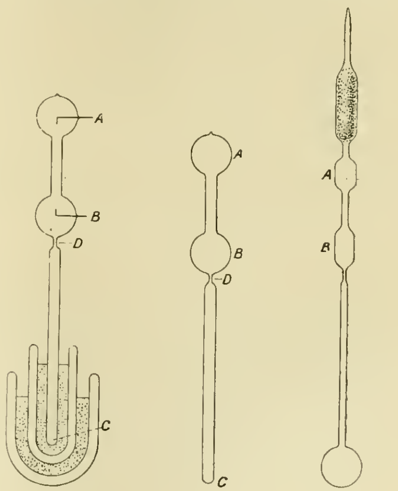


FIG. 1. FIG. 2. FIG. 3.

pass the spark through vacuum tubes prepared in this manner, their excellent exhaustion was revealed by great resistance to the passage of the discharge, and the high phosphorescence of the glass. Two tubes, kindly prepared by Sir William Crookes with platinum electrodes that he had previously sparked to remove gases and impurities on the glass before filling with dry air, gave, when treated in the manner described, such high vacua that the tubes had to be heated in order to get any spark to pass. Thus it is proved that the tension of solid nitrogen and oxygen at the temperature of boiling hydrogen is below the millionth of an atmosphere, seeing there is less difficulty in getting a discharge to pass in tubes exhausted to this extent. In order to get some definite idea of the limit of the exhaustion produced, two tubes, such as have been described as suitable for the liquid hydrogen experiments, might be joined together and filled with oxygen or nitrogen at atmospheric pressure, and simultaneously exhausted with the mercurial pump to a small fraction of an atmosphere, and then sealed off from the pump

and each other. One of these two identical tubes could then be subjected to the hydrogen cooling, following the directions already given, and the two vacuum tubes now compared. If there was a marked difference in resistance to the passage of the discharge in the frozen tube, then something must have condensed, and by a few tentative trials a limit might be reached when the initial exhaustion was unaffected by the hydrogen cooling. Such experiments have not yet been made. The presence of any vapour of mercury would require to be carefully eliminated, otherwise the method would not be satisfactory. Tubes that are prepared without taking special precautions to exclude organic matter and water from the glass, deteriorate, especially with electrodeless tubes after the discharge has taken place for some time.

The rapidity with which the vacua are attained is such as theory would suggest, assuming a hole of a square millimetre in section through which the air rushes into the condenser and that a velocity of current between 600 and 700 feet a second is attained, then a vessel of 20 c.c. capacity could be reduced in pressure in 1 second to 1/10 of the initial pressure, and if the same rate is continued at the end of 60 seconds to $(\frac{1}{10})^{60}$. Sir George Stokes has been good enough to consider the problem and writes as follows:—

"Let V be the volume of the vessel, A the area of an aperture by which the air is conceived as rushing out with the velocity v, ρ the density of the air in the vessel at the time t, D the initial density, that is, the atmospheric density.

"Then, according to our hypothesis, $Av.dt$ is the volume of air, and, therefore, $Av\rho.dt$, the mass of air, which rushes out in the time dt. But this equals the loss of mass of air in the vessel during the time dt, and, therefore,

$$Av\rho \,.\, dt = -V d\rho,$$

a differential equation of which the integral is

$$\rho = De^{-Avt/V}.$$

"Suppose now V to be 20 c.c., or 20,000 c.mm., A to be the area of a circle of 1 or 2 mm. diameter, say 2 sq. mm., v to be 333 m., or 333,000 mm., t (in seconds) to be 60; then

$$\log_e \frac{D}{\rho} = \frac{2 \times 333{,}000 \times 60}{20{,}000} = 1998,$$

$$\frac{D}{\rho} = 5254 \times 10^{434}.$$

"This would give a density of almost inconceivable smallness. Doubtless the supposition made above as to the rate of discharge is very wide of the mark, being much too great. If the velocity of rushing is about half the velocity of sound, the ratio of densities would become 72×10^{217}. If so it is satisfactory to find that the mathematical following out of the hypothesis leads to a density of the residual air in the vessel which is enormously below what suffices to account for the observed result." A practical mode of rapidly attaining a high vacuum in any vessel is to displace the air with carbonic or sulphurous acid, either at the atmospheric or under diminished pressure, and then to freeze out the remaining gas by the use of liquid air, just as in the experiments with liquid hydrogen.

The first vacuum tube was an electrodeless one, the air had not been dried, nor the glass specially cleaned. On spectroscopic examination it showed hydrogen lines bright along with the second or compound line spectrum of the same gas, and a series of bright bands defined on the less refrangible side, diffuse on the more refrangible, which occur in the yellow, green, blue, and indigo. These bands were found to be identical with the carbonic oxide spectrum. With a Leyden jar in the secondary circuit the line spectrum of hydrogen disappeared, leaving the second spectrum fainter; but the carbonic oxide bands remained bright, and there was no appearance of the hydrocarbon spectrum. The second tube had aluminium electrodes, and, like the last, had no special treatment in filling in the air. This tube showed also the line spectrum and the second spectrum of hydrogen: the latter being bright along with the carbonic oxide spectrum; but on sparking the latter disappeared. No appearance of the hydrocarbon spectrum could be detected, but there was a suspicion of bands in the indigo like the negative pole spectrum of nitrogen. The addition of a Leyden jar brought out nothing new, only intensifying the line spectrum of hydrogen, while leaving the second spectrum bright. In neither of the above tubes could any lines of nitrogen or oxygen be recognised. The third tube was filled with air drawn over cotton wool, red-hot copper oxide, and phosphoric pentoxide, no rubber joints being employed. The spectrum showed the carbonic oxide bands and the hydrogen line spectrum as before. Only the second hydrogen spectrum was feeble. There was a yellow line W.L. 5849, identical with one occurring in the natural gas from the King's Well at Bath. In a paper on "The Liquefaction of Air and the Detection of Impurities" (*Chem. Soc. Proc.*, November 1897), the separation of helium from this gas is described by liquefaction and fractionation, and it was observed that during the sparking the helium lines were well marked along with "*others, the origin of which must be settled later.*" It was further observed, "*With a modified form of apparatus it will be possible to collect any residuary gas from the use not of 3 cubic feet of air or Bath gas, but from hundred of cubic feet of such products.*" The helium and other associated material was shown to be more volatile than nitrogen. Pursuing this course of investigation in the summer of this year, the volatile portion of air was examined, when the presence of material giving the same lines as Bath helium was recognised. While this investigation was in progress, Prof Ramsay and Dr. Travers observed the same spectrum in the more volatile portion of argon which they have associated with a new element called neon. The use of liquid hydrogen, as described, proves that the most characteristic line of neon in the yellow, about W.L. 5849, can be detected in 25 c.c. of ordinary air, and the presence of helium in the atmosphere is confirmed.[1]

A fourth tube, filled like the preceding one, had a phosphoric pentoxide tube left on. This showed again the carbonic oxide bands, but no hydrogen lines could be detected; while the oxide of copper ought to have removed all free hydrogen and transformed all the organic matter into carbonic acid and water. Yet it appears that the spectrum of the carbon compounds is difficult to remove from electrodeless tubes, probably owing to carbonic acid coming from the glass. There were some broad diffuse bands that may arise from the drying agent. The absence of hydrogen in this tube suggests that its presence in the third tube was due to vapour of water coming slowly from the glass. I am greatly indebted to Prof. Liveing for making a careful examination of the spectra of these tubes.

Sir William Crookes was good enough to prepare two tubes with platinum electrodes, which he sparked in vacua till all hydrogen disappeared, and then filled with dry air, but without the use of red-hot copper oxide or any agent for the absorption of carbonic acid or the destruction of organic matter. After the cooling with liquid hydrogen, he found on spectroscopic examination, in one no hydrogen, but two faint lines, one about 5852 W.L. and the other 5676 W.L. The second tube showed the same yellow about 5852, the helium line along with 5939 and 6145, the hydrogen lines C and F, and some red lines. The observations of Crookes confirm the presence of neon, helium, and hydrogen. The absence in his tubes of the carbonic oxide spectrum is important, seeing all the electrodeless tubes gave this spectrum. In these tubes the vacuum was very high, and it was difficult to observe the gaseous spectrum. Still, the fact of finding hydrogen in one and not in the other, leaves the presence of free hydrogen in the atmosphere as a question for further inquiry. The tube that did not contain hydrogen was heated very hot in order to get a discharge, and then the spectrum showed some bands like the negative glow of nitrogen. Occasionally, a jar discharge was got to pass, and when this took place the nitrogen lines could be seen. An electrodeless tube filled carefully with oxygen made from fused chlorate of potash, which was contained in an extension of the vacuum tube, gave nothing but the carbonic oxide bands. In future experiments it will be easy to concentrate all the least volatile material in air or other gases, and thereby to make a more thorough examination of the spectrum. In the meantime my object is to show one of the scientific uses of liquid hydrogen.

I have to thank Mr. Robert Lennox for efficient aid in the conduct of the difficult experiments. Mr. Heath has also helped in the work.

[1] In a paper along with Prof. Liveing, "On the Spectrum of the Electric Discharge in Liquid Oxygen, Air, and Nitrogen" (*Phil. Mag.*, 1894), we noted that during the distillation and concentration *in vacuo* of liquid oxygen and air under diminished pressure, that two bright lines appeared in the spectrum at wave-length 557 and 555, and that one of these lines was very near the position of the auronal line. These lines are now attributed by the same chemists to a new element, crypton.

GEOLOGY OF SOUTH-WESTERN NOVA SCOTIA.

A REPORT, by Dr. L. W. Bailey, dealing with the geology of a portion of the Province of Nova Scotia, appears in the annual report of the Geological Survey of Canada (vol. ix., 1896), just issued. Until recently, but little was known of the geology of this region; indeed, the only important references thereto are those contained in the "Acadian Geology" of Sir Wm. Dawson, and these were almost wholly confined to the seaboard. The interior, being essentially unfit for settlement and difficult of access, received little or no attention until, in the year 1891, as a consequence of the interest aroused in gold mining, something like a systematic survey was begun. The results of this exploration, extending over several years and including four counties, with portions of a fifth, are contained in the volume just published.

Glacier-ploughed trough in Cambrian Rocks, Lockport Island, Nova Scotia.

Of the formations described, that occupying the largest area is granite, but this, instead of being represented, as in previous descriptions, as simply forming a belt of uniform width and constituting the axis of the peninsula, is shown to possess an exceedingly irregular contour, besides being disclosed either by extrusion or denudation in many detached areas. Enwrapping the granite, but along the lines of contact invaded by the latter in the most complicated way, are the rocks usually styled the "Nova Scotia gold series." These are also styled Cambrian, though it is stated that as yet no positive proof that such is their age has been obtained. The rocks appear to be essentially non-fossiliferous, and by some authors are regarded as being Pre-Cambrian. They consist of three principal members, of which the lowest and chief one is composed of heavy beds of quartzite alternating with slates, the second of argillites which are often parti-coloured, and third of black slates, usually highly charged with pyrites. Their thickness is very great, certainly 10,000 feet, and probably much more than this. Ridged up by pressure from the Atlantic side, but at the same time affected by strains more or less transverse to the trend of the coast, they present a series of dome-like folds, varying from nearly circular to elliptical or linear in outline, of which the centre is usually composed of quartzites and the encircling beds black or coloured slates. It is in connection with these domes or anticlines that the principal dislocations have been determined, and, on account of their intimate connection with the development of gold veins, have received much attention and are somewhat minutely described. Quite a number of mines exist within the area considered, and some of them are yielding large returns. In the neighbourhood of the granite the Cambrian rocks are greatly altered, but gold veins are comparatively few in connection with the more highly metamorphosed strata.

In addition to the supposed Cambrian rocks there are, in Digby and Annapolis counties, considerable areas occupied by more recent rocks, viz. Eo-Devonian and Triassic. These are confined to the neighbourhood of the Bay of Fundy, the former containing large numbers of fossils of about the age of the Oriskany sandstones of New York, and the latter wholly unfossiliferous, embracing red sandstones in the Annapolis Valley and traps in the North Mountains, which overlook the latter from the northern side.

The region presents many features of interest as regards its superficial geology, the most striking being the numerous fiord-like indentations of the coast, the great numbers and large size of the erratics with which the surface is strewed, the occurrence of kames, or horse-backs, in some instances thirty miles in length, and the evidences afforded on the coast of deep glacial ploughings. One striking instance of this is given in the accompanying photograph—but others, of much greater depth and breadth, have been observed.

The report is accompanied by a coloured map, on which, in addition to the separation of the various rock-formations, the more important "Domes" and gold districts are clearly indicated.

SCIENTIFIC WORK OF THE U.S. DEPARTMENT OF AGRICULTURE.[1]

WEATHER BUREAU.

ARRANGEMENTS have been made to establish stations for making meteorological observations and displaying hurricane signals at Kingston, Santiago de Cuba, Santo Domingo, St. Thomas, Barbados, Dominica, Trinidad, Curaçao, and Barranquilla.

When the West Indian service is fully established twice-daily reports will be received, not only from the stations named, but also from Habana, Nassau, Vera Cruz, Tampico, Coatzacoalcos, and Merida. The improved storm-warning service will largely benefit the commercial interests throughout the West Indies.

The Central Meteorological and Magnetic Observatory of Mexico has begun the equipment of about thirty stations in the Mexican Republic, with the most approved meteorological instruments, and will establish a meteorological service similar to our own. When completed, an exchange of reports, especially those relating to the approach of West Indian hurricanes and "northers" in the Gulf of Mexico, will be effected.

Aerial observations by means of kites were continued during the year. It was hoped to establish at least twenty stations, but it was found that only sixteen could be completely equipped. It is too early to express an opinion regarding the value of the observations already secured in the aerial work of the Bureau.

The importance of the study of meteorology in the United States has been kept in mind, especially in the assignment of observers to duty at points where there are colleges or universities not already provided with instructors in meteorology, and during the past year the courses in meteorology have been strengthened in a large number of high schools and academies.

The Bureau has begun the collection of statistics of loss to farm property, including live stock in the fields, by lightning, so as to determine the frequency of lightning stroke and the amount of property destroyed annually by that phenomenon.

VEGETABLE PHYSIOLOGY AND PATHOLOGY.

The work of this Division is carried on with a view of obtaining additional light on the conditions governing the growth and

[1] Extracted from the Report on the work of the U.S. Department of Agriculture for the year ending June 30, 1898.

production of cultivated plants, with special reference to diseases, nutrition, and development of new and improved sorts by breeding and selection.

During the year valuable knowledge was obtained relative to increasing the sugar and starch-producing power of plants, and the effect of soil foods on their growth and productiveness.

The work of hybridrising the sweet orange with the hardy trifoliate, with a view of obtaining a variety resistant to cold, was pushed on, and about one hundred and fifty hybrids obtained. In addition to this about one thousand hybrids of other citrus plants were obtained. Considerable work was done in crossing pineapples, and as a result two hundred and fifty-nine hybrid seedlings were secured. These produced plants of great vigour, and confirmed the belief that by this means there may be produced fruits which will be larger, of better quality, better shippers, and more resistant to blight. Similar work was carried on with pears and with wheat and other crops.

Biological Survey.

With a view to determining the areas best adapted for various crops, the Biological Survey has been engaged for several years in collecting data for mapping the natural life zones of the United States. A detailed study of the distribution of the native animals and plants has been made in the belief that areas inhabited by indigenous species coincide with those most suitable for certain varieties of fruit and cereals and for breeds of domesticated animals. This investigation has now progressed far enough to permit the publication during the past year of a revised map of the life zones of the United States and two reports containing the results of more general interest to farmers and horticulturists.

One of these reports comprised a description of the life zones and crop zones of the United States, with lists of the more important varieties of fruits and grains adapted to each area; the other, an investigation of the geographic distribution of some of the more important cereals.

The Biological Survey is often called upon to determine the value of birds and animals to practical agriculture. A careful study is made of the food of useful and injurious birds and mammals, and thousands of stomachs of birds are examined in the laboratory. Two thousand three hundred and twenty-nine stomachs, mainly of sparrows, swallows and woodpeckers, were examined during the year. A report has been published on the native cuckoos and shrikes (see p. 61), and reports on flycatchers and native sparrows are in preparation. Several of the latter birds feed largely on weed seed during the winter, and it is a matter of no little interest to determine how far they can aid the farmer in checking the increase of noxious weeds. The importance of this work is emphasised by the increasing demand made on the Department for information and publications on birds, in consequence of the recent widespread popular interest in ornithology.

Forestry.

At the end of the fiscal year the creation of the New York State College of Forestry and the election of Mr. B. E. Fernow to the directorship created a vacancy in the position of Chief of the Division, which Mr. Fernow held for twelve years, and Mr. Gifford Pinchot, of New York, was appointed his successor.

One of the most useful lines of work has been an investigation of the forest conditions of the State of Wisconsin, in co-operation with the State Geological Survey (see p. 82).

The accumulated data of the investigations in timber physics has been worked out in part and yielded some most important results, among which the law that the strength of a beam at the elastic limit is equal to the compression strength of the material, which was established by the tests of the Division, will influence the practice in the use of wood for construction most advantageously.

Agrostology.

Through the efforts of this Division the needs of the several sections of the United States are being determined, and the forage problems which they have to meet are being found. The work leads to a better knowledge of the distribution and value of the native grasses and forage plants, as well as the peculiar conditions of soil and climate best suited to their growth. More than 500 varieties of grasses and forage plants valued for forage have been grown in the grass garden on the grounds of the Department during the past season.

Over 5000 specimens of American grasses have been identified during the year, and nearly 3000 sheets of herbarium specimens mounted and added to the National Herbarium. The grass collection now in the Department numbers over 30,000 sheets.

Soils.

Records have been continued of the moisture content of some of the principal soil areas in the country with the electrical method of moisture determination. As the soil is the immediate source of the water supply of plants, this record becomes an essential part of climatology, and it seems probable that this work of the Division of Soils, in connection with the present work of the Weather Bureau and of the Division of Statistics, will develop a distinctively new line of agricultural climatology. This work is closely related to the work of the Weather Bureau, but is supplementary to it. It includes the record of evaporation to which the plant is subjected, the water supply maintained by the soil for supplying the loss due to this evaporation, and the intensity of the actinic and heat radiations which influence the physiological activities of the plant. Numerical values can be given to the evaporation and to the soil-moisture conditions, so that it is possible to express numerically the relative conditions of plant growth from day to day so far as these two important factors of evaporation and water supply are concerned. This will add greatly to the practical value of our knowledge of climatology.

Among the most important lines of work which the Department can take up for the tobacco grower is the study of the diseases in the tobacco bed and the comparatively few diseases in the field, and particularly the study of curing and fermentation. A large amount of research work has been done, particularly in Germany, in the fermentation of tobacco, but very little is yet known of the changes which go on in the process or regarding the specific agents which bring about these changes. So much information and practical benefit have been derived from a study of butter and cheese, in the control of the ferments and bacteria which produce the texture and flavour of the product, that it is very desirable that similar knowledge in the curing and fermentation of tobacco, and similar control of the finished product, should be secured. This work will require very careful study of the changes in the fermentation pile in the different tobacco districts.

If American tobacco growers are to attempt to raise a product equal to that of Cuba and Sumatra, and if this is to be done not by chance, but through systematic, scientific investigations, then the soils and other conditions of growth must be thoroughly understood, and the fermentation changes carefully worked out in Cuba and Sumatra. It is necessary, therefore, that a soil expert and a bacteriologist extend their work to these foreign countries.

Botany.

The Division of Botany is at work to reduce the importations into the United States of the little things that have been costing the Americans 8,000,000 dollars annually. Western States are now growing chicory. In 1896 16,317,888 pounds were imported, in 1898 only 315,707 pounds of raw chicory were imported. The farmers of Michigan, Nebraska, and other States will now furnish the supply. Ginseng is also a promising plant for cultivation. The Division of Botany will make tests to protect farmers and merchants against foul and fraudulently imported seeds, and test the importations of the Department before distribution.

The distribution of young plants to various parts of the country was continued during the year, reaching a total of nearly 190,000, including bulbs. Among these were olive, fig, and camphor plants and cuttings. Attention is called to the fact that the growing of rubber plants, even in the most favourable localities of Florida, can hardly be commercially successful.

Experiment Stations.

The annual grant of 720,000 dollars for the agricultural experiment stations is supplemented by 400,000 dollars from the States. About four hundred reports and bulletins were issued by the stations in 1897, which were directly distributed to over half a million addresses.

The need and value of scientific researches on behalf of agriculture are now very clearly understood, and the number and importance of institutions organised for this work are constantly increasing in all parts of the world. Nowhere has so

comprehensive and efficient a system of experiment stations been established as in the United States. In the scope and amount of their operations, and in the thoroughness with which the useful information they obtain is disseminated among the farmers, the stations are unsurpassed.

The stations are not the only means for the education of the farmer. Agricultural colleges, farmers' institutes, boards of agriculture, and various other agencies have been established to instruct the farmer regarding the present status of agricultural science as applied to his art. It is the business of the experiment stations, on the other hand, to advance knowledge of the facts and principles underlying successful agriculture, and to teach the farmer new truths made known by their investigations. The act of Congress creating the stations clearly defines their functions to be the making and publishing of original investigations. Wherever a station has neglected this, and merely endeavoured to educate the farmer, we find a weak station, and wherever a station has earnestly devoted itself to original investigations, we find a strong station. The station may very properly lend its influence to strengthening the influence and work of the educational agencies established for the farmers' benefit, but it fails to fulfil its real mission when it resolves itself into a bureau of information, or devotes a large share of its energies to the compilation of popular treatises on agriculture. It is gratifying to observe that the original investigations at the stations are increasing in number and improving in quality.

The movement for the extension and popularisation of agricultural instruction is growing in importance. The short and special courses in the colleges, the farmers' institutes, and the home-reading circles are attracting larger numbers of farmer students. The effort to introduce nature teaching, largely on subjects relating to agriculture, is being actively prosecuted in several States.

The investigations upon the "nutritive value of various articles and commodities used for human food" have been pursued as hitherto, in co-operation with agricultural colleges and experiment stations and other educational institutions. Special investigations with the respiration calorimeter have been made, in which not only the nutritive value of the food consumed but also its relation to the heat and energy evolved by the human body during periods of rest and work have been measured with a completeness and accuracy hitherto unknown. These investigations are not only of very high scientific importance, but have also already given promise of useful practical application. The results of the careful studies of the dietaries of people of different occupations, made in connection with the nutrition investigations, have been widely republished.

It is believed that the nutrition investigations of the Department have already done much to establish a scientific basis for the courses of instruction on the food and nutrition of man, which are rapidly increasing in number and importance throughout the country.

Practical Experiments in Nature Teaching under State Authority.

In New York, the College of Agriculture of Cornell University has a special State grant of 25,000 dollars per annum to be used in aiding the introduction of nature teaching into the common schools and the carrying on of simple agricultural experiments in different parts of the State. The plan followed has been to employ experts in the different sciences to prepare brief leaflets containing lessons on various subjects for the use of teachers in the common schools. These leaflets are distributed to teachers throughout the State, and there has been such a large demand for them from teachers in other States that arrangements have been made to sell them at a nominal price.

The professors and other agents of the university attend meetings of teachers from time to time, to explain the scope of this work and to show the teachers how to carry out simple instruction on nature topics. Many of these leaflets relate directly to agricultural subjects. For example, in one leaflet the teacher is instructed to have the children plant squash seeds, take some of them up at intervals to learn how the seeds germinate, and watch what happens to the little plants as they grow. At another time the children are encouraged to plant little gardens and carefully watch some of the things that grow in them; or they study some insect which preys upon fruit, or make collections of the insects about their homes, or watch them to see whether they are doing things good or bad for the farmer. This movement has rapidly increased in popularity, and the leaflets are used in many city schools as well as in those in the country. Hundreds of simple experiments with fertilisers on potatoes have been carried on in different parts of the State with some of the money above referred to. For carrying on all this work the university has employed its teaching force and a small corps of special agents and clerks.

In Indiana, Purdue University has undertaken a similar work, though its funds have not permitted it to make it very extensive. A number of leaflets have been prepared by different members of the faculty, and have been sent out to teachers throughout the State. In a number of other States nature teaching has been introduced into the common schools, but for the most part in the schools in the larger towns and cities, where there were teachers who had had some training in natural science. As a result of the widespread interest in this subject, teachers' manuals and text-books for instruction in this branch are being prepared.

Animal Diseases.

The Bureau has continued experimentation with antitoxin serum for the prevention and cure of hog cholera. Congress, at its last session, made a grant in aid of this work, which became available at the beginning of the present fiscal year. Buildings were erected at an experiment station, and animals purchased to make the serum in sufficient quantities to conduct extensive research. The results of the previous year have been corroborated. Eighty per cent. of the animals treated were saved, while a like per cent. of the check herds not treated died. This justifies the Department in efforts to supply in future to herdsmen throughout the country such serum as can be made. It is for Congress to determine whether serum shall be given free or a charge be made covering the expense of manufacture, which would be about fifteen cents for each animal.

The study of tuberculosis, with reference to both men and animals, has been continued, and the results so far obtained indicate that experiments already begun in this line should be continued, as there is a prospect of more satisfactory results.

Experiments in dipping cattle to kill the ticks which cause Texas fever were continued, with the gratifying result that a substance has been found which will destroy all the ticks on an animal at a single dipping, and will not injure the animal.

Chemistry.

The Division of Chemistry during the past year has continued its work on the composition and adulteration of foods. An elaborate bulletin, treating of the composition of cereals and all cereal products, represents the results of the principal amount of work in this direction. Another bulletin is devoted to the composition and uses of Indian corn, and this bulletin was prepared especially for presentation at the third International Congress of Applied Chemistry in Vienna, which met in July 1898.

The Division continued during the year its investigations of the possibilities of producing high-grade sugar beets in various parts of the United States. As a result of the extensive chemical studies conducted, the area suitable to the production of the best beets has been more definitely delineated. A few years more of studies of this kind will mark out in a practical manner the areas where beets of the highest grade can be produced.

Entomology.

General investigations have been carried on in this Division through the year upon insects injurious to garden crops, to shade trees, and to citrus trees and fruit. The general experimental work, with remedies, has comprised especially careful investigations of the availability of hydrocyanic acid gas in the disinfection of seeds in bulk and of plants and nursery material, and further experiments with arsenicals and various oil mixtures in order to determine their effects on plants in dormant condition and in foliage.

A preliminary attempt has been made to introduce from Southern Europe into California an insect which is responsible for the fertilisation of the Smyrna figs of commerce. The Entomologist visited California in the spring of 1898, and found that conditions were ripe for such an attempted introduction, and an agent in Europe will, during the coming year, endeavour to take the necessary steps to bring about this introduction, which, it is hoped, will result in the production by California of a fig equal to the Smyrna fig.

A successful importation has been made of an important parasite of certain large scale insects.

Other important work carried on under this Division during the year has included the sending successfully of beneficial species to foreign Governments suffering from outbreaks of the white or fluted scale, the preparation of an account of the work accomplished during the past two years against the San José scale, an investigation of the injurious grasshoppers of the Western States, work upon remedies to be used against the house fly, suggested by the growing belief in the importance of this insect as a carrier of disease; work upon the geographic distribution of injurious insects of the United States, and experimental work in agriculture.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Board of Electors will meet on February 11 for the purpose of electing a successor to the late Professor of Pathology, Dr. Kanthack. Candidates are to send their names to the Vice-Chancellor on or before February 4.

The Clerk Maxwell Studentship in Experimental Physics has been awarded to Mr. J. S. E. Townsend, of Trinity College.

AT a meeting in Birmingham, last week, of the Court of Governors of Mason University College, Mr. Chamberlain, in his capacity of president of the College, occupied the chair. In the course of his remarks, Mr. Chamberlain mentioned that the endowment fund of the proposed University of Birmingham had made very considerable progress, and that further assistance was to be expected from the leading managers and directors of the great limited liability firms, who were inclined to take a proper view of their responsibilities and obligations in a question upon which the future of the city so largely depended. Referring in more detail to the University scheme, Mr. Chamberlain emphasised the importance of establishing a faculty of commerce in connection with the curriculum. "Whilst," he remarked, "we shall always hope that in the University the highest culture will receive its due attention, still I think it important, to justify our separate existence, that we should have distinctive features in our curriculum, and nowhere shall we find that better than in such a faculty of commerce." Mr. Chamberlain's ambition is that in the future the business men of Birmingham and the district who enjoy a fair social position will not consider themselves properly equipped for their career without having obtained a degree in the University faculty of commerce.

THE annual meeting of the Geographical Association was held on Wednesday, January 11. As already stated (p. 238), the Association was founded in 1893, and its aim is to raise geography as a school subject from its present low level in secondary schools by spreading the knowledge of all such methods of geographical teaching as bring into play the pupil's intelligence and reasoning powers, instead of merely loading the memory with names and isolated facts. A memorial to boards of public examiners on the subject of reforms in examinations in geography has already, in many cases, led to a marked improvement in the character of the questions set. Amongst other means adopted by the Association for the furtherance of its aim, are lectures and meetings for discussion; the adoption of the *Journal of School Geography* as a medium for the publication of information of service to teachers of geography; and the circulation of lantern slides (maps, diagrams, and views of scenery). The question of a syllabus has been before the Association for some time, but the Committee are unwilling to lend their authority to any definite scheme of work, preferring rather to encourage individual teachers to explain in detail their own ideas of method, the outcome of their own practical experience. Mr. Douglas W. Freshfield, the president of the Association, delivered a short address at the annual meeting, and in the course of his remarks he referred to points dealt with in the report, and commended the decision of the Committee in not insisting upon any particular form of syllabus.

A CONFERENCE on science teaching in connection with the Technical Education Board of the London County Council was held, under the direction of Dr. Kimmins, at the South-West London Polytechnic, on January 12 and 13. The following papers occupied the morning of January 12:—"The Teaching of Optics," by Mr. Sanderson, headmaster of Oundle School; "The Method of Teaching Science," by Mr. Frank Weedon, of Alleyn's School, Dulwich. Dr. Garnett presided. In the afternoon Miss Edna Walter, of the Central Foundation School for Girls, and Mr. Burkhardt, of Owen's School, Islington, read papers on "The Teaching of Chemistry." Prof. Armstrong occupied the chair. At the third meeting Mr. S. H. Wells, Principal of the Battersea Polytechnic, and Mr. S. Whalley, of Simon Langton School, Canterbury, read papers on "The Teaching of Elementary Mechanics in Schools." Prof. Hudson Beare presided. At the fourth meeting, papers on "The Teaching of Heat," by Mr. Arthur Adamson, of the Central Higher Grade School, Manchester; and on "Magnetism and Static Electricity," by Dr. T. Buchanan, of Gordon College, Aberdeen, took up the attention of the meeting. Prof. Ewing presided. It is much to be hoped that this very successful experiment will be repeated next year. The attendance at each meeting was large, and included, in addition to many science teachers from all parts of the country, several of the inspectors of the Science and Art Department, and such well-known men of science as Dr. Gladstone and Captain Abney. Enthusiastic discussions followed each paper, and the number of practical hints which were to be gleaned at each meeting well repaid attendance. The collection of apparatus, specially designed for use in schools, which Dr. Kimmins had got together and had arranged in the physical, chemical and mechanical laboratories, should do a great deal in the direction of acquainting science masters with what other teachers are doing. Many of the exhibits were original, and highly ingenious.

AT a meeting of Convocation of the University of London, held on Monday, it was resolved:—"That, in the opinion of this house, the new regulations for the matriculation examination tend to discourage the study of modern languages in schools, by making them entirely optional and alternative to science." The following resolution was referred to the standing committee:—"That the examination in general elementary science should be restricted to the first part of the subject, and comprised in one paper; the second part to be made optional with the other sciences, and a third language to form a separate and obligatory section taking its place."

AT the annual general meeting of the Headmasters' Association, on Friday last, the following resolutions were adopted: (1) "That this Association cordially welcomes the Board of Education Bill as a first step towards the organisation of secondary education in England, and is of opinion that the consultative committee proposed therein ought to be permanent and to contain representatives of the Universities and of bodies of teachers." (2) "That this Association records with satisfaction the statement made by the Lord President in introducing the Board of Education Bill—viz. that the proposed Education Office would probably be so organised as to consist of three departments, dealing with primary, secondary, and technical education respectively."

THE Association of Technical Institutions held its annual conference in London on Thursday last. Lord Spencer was elected president for the ensuing year, and delivered an address, on which he dwelt on the extreme importance of improved technical education in the interests of our commerce and industry, and indicated some of the more pressing reforms that were needed. The following resolution was afterwards carried:—"That the Association desires to place on record its appreciation of the Board of Education Bill, 1898, as a first instalment of legislation on the lines recommended by the recent Royal Commission, and its hope that the Government may see its way to proceed further in the same direction."

THE Association of Directors and Organising Secretaries for technical and secondary education held its annual meeting on Friday last, Mr. H. Macan presiding. The chief subject discussed was the Government Secondary Education Bill, and the constitution of the proposed local authority to be responsible for technical and secondary education. It has already been agreed among the bodies interested that on the new local education authorities the County Council should have half the representation, and the School Boards a third, the remainder being made up of co-opted members. At Friday's meeting, some hostility was shown towards the proposal to give School Boards so large a representation as a third, or even any at all, the opinion being expressed that the present powers possessed by County Councils are sufficient to secure the representation of all educational interests in the areas of administrative counties. Among the resolutions agreed to was one expressing the view

that, in the opinion of this Association, it was both undesirable and impracticable to draw any line of separation between secondary and technical education in any legislation concerning central or local authorities, and another to the effect that in no case should a permanent consultative committee be attached to the Board of Education.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 15, 1898.—"The Action of Magnetised Electrodes upon Electrical Discharge Phenomena in Rarefied Gases." Preliminary Note. By C. E. S. Phillips. Communicated by Sir William Crookes, F.R.S.

The experiments described in this paper were undertaken in order to study, more especially, the action of magnetised electrodes upon the phosphorescent afterglow which is often seen to illuminate the inner surface of the glass walls of vacuum tubes when an electrical discharge has passed within them.

The apparatus employed consisted of a glass bulb, nearly spherical in shape and about 2½ inches in diameter, open at both ends, for the purpose of inserting and sealing into position, two soft iron electrodes, so placed that their pointed ends were within 1/16 inch of one another.

Each electrode had a screw-thread of suitable pitch cut upon it in order that two brass cups, when screwed into position and sealed with cement to the glass, might serve to keep the electrodes central, to reduce the possibility of their rushing together under the influence of strong magnetic forces, and to seal air-tight the two ends of the bulb.

Suitable arrangements having been made for strongly magnetising the electrodes by means of a powerful external electro-magnet, the bulb was then connected to a Sprengel air-pump and slowly exhausted. During this process the usual luminous phenomena were observed whenever a discharge was passed through the bulb; while on magnetising the electrodes the results obtained were, in some cases, very remarkable

A rarefaction having been obtained such that a three-inch spark from a ten-inch Apps induction coil could scarcely start the glow, it was observed that, after a strong stimulation of the bulb had taken place and then been stopped (the electrodes meanwhile remaining unmagnetised), on exciting the magnet a luminous ring suddenly appeared within the bulb, between the pointed ends of the electrodes, and in a plane at right angles to the direction of the magnetic lines of force. It shone brightly for a moment, when the magnet circuit was "made," and it was more sharply defined at high exhaustions—becoming, in fact, hazy and indefinite if the pressure within the bulb were slightly increased. Even with the connecting wires between the coil and the bulb completely removed after stimulation, the ring formed as well as ever when the magnet was turned on. At the moment the ring appeared within the bulb the glass walls became electrically charged so strongly that, in some cases, a spark could be seen to pass between the glass and either of the exposed ends of the electrodes at the moment the magnet was excited. It was further noticed that the ring was in rapid rotation and also very sensitive to variations in the electrical charges, upon the bulb.

Under certain conditions a second ring formed concentrically with the first. Experiments were also made with external magnetic electrodes, and irregular green splashes and puffs of white cloudy light appeared in the interior of the exhausted vessel when the electrodes were magnetised.

Geological Society, January 4.—W. Whitaker, F.R.S., President, in the chair.—Capt. A. W. Stiffe exhibited a fossil *Cardium* (?) from the beach at the foot of the cliffs of Ormara (Makran Coast).—"Geology of the Ashbourne and Buxton Branch of the London and North-Western Railway: Ashbourne to Crake Low," by H. H. Arnold-Bemrose. The southern part of the new railway from Ashbourne, through Tissington and Crake Low to Buxton, exhibits several sections in Trias, Boulder Clay, Mountain Limestone, and Yoredale Beds. Interstratified with the latter is a thick bed of volcanic ash, with thinner intercalations of tuff. Within a mile of Tissington ash is exhibited four times in the cuttings, and according to the view of the author it is the same bed repeated by basins and domes, one of the latter of which is faulted. While the rocks succeeding the ash in some places are limestones, cherts, and shales of Yoredale type, in one section they resemble more closely the upper beds of the Mountain Limestone. The limestones are often dolomitised.—"The Oceanic Deposits of Trinidad," by Prof. J. B. Harrison and A. J. Jukes-Browne. The object of this communication was to present some observations on the succession and geological relations of the beds which have long been known in Trinidad as the Naparima Marls. In his historical introduction Mr. Jukes-Browne deals with the writings of Mr. Guppy and Prof. Harrison, and shows that three definite issues are thus raised: (1) Are the Nariva Beds above or below the Naparima Marls? (2) Do the *Globigerina*-marls occur in the Naparima district, and, if so, are they connected with the Radiolarian marls, or are they part of a separate formation? (3) What is the relation between the San Fernando Beds and the other groups? Mr. Guppy and Prof. Harrison agree in answering the first part of the second question in the affirmative, and in stating that the two marls are closely connected together. It appears that the *Globigerina*-marls occupy the place of the basal chalks of Barbados, but are much thicker, while the radiolarian rocks are thinner, and the interbedded volcanic ashes so frequent in Barbados are wanting in Trinidad. Chemical and microscopic analysis of the *Globigerina* and radiolarian beds are given, and, compared with similar analyses of the Barbadian deposits, they show that more quartz and argillaceous matter occur in Trinidad. The following correlation is proposed:—

BARBADOS.	TRINIDAD.	
Coral Rocks. / Bissex Beds.	Moruga Series.	Pleistocene and Pliocene.
Oceanic Beds.	Naparima Marls.	Miocene.
Scotland Beds. Upper.	San Fernando Beds.	Oligocene and Eocene.
Scotland Beds. Lower.	Nariva Series.	

The Oligocene and Eocene Beds are of shallow-water origin, and seem to be unconformably covered by the Naparima Marls.

PARIS.

Academy of Sciences, January 9.—M. van Tieghem in the chair.—On the hysteresimeter constructed by MM. Blondel and Carpentier, by M. Marcel Deprez. The author describes an instrument for the measurement of hysteresis, constructed by him about four years ago for the *Conservatoire National des Arts et Métiers*, the principle of which is identical with that of the hysteresimeter recently invented by MM. Blondel and Carpentier, the only differences being that the author's instrument was of dimensions suitable for measuring the hysteresis of iron rings of the size actually used in dynamos, and contained an electro-magnet instead of a permanent magnet.—The cryoscopy of urine, by M. Ch. Bouchard. From the observed depression of the freezing point of urine, suitably diluted if necessary, the depression due to sodium chloride present is subtracted, and the mean molecular weight of the rest of the solid matter determined in the usual manner. In a man in a normal state of health the value of this mean molecular weight is about 62, rarely falling below 60, or rising above 68. In disease the value of this constant is usually raised, varying from 68 to 112.—Histology of the skin. Definition and nomenclature of the epidermal layers in man and mammals, by M. L. Ranvier. Seven distinct layers are described as existing in the epidermis of man and mammals, each layer being characterised by perfectly clear physical characters and chemical reactions. The names given to these strata are: *Germinativum*, *filamentosum*, *granulosum*, *intermedium*, *lucidum*, *corneum*, and *disjunctum*.—Observations of the total eclipse of the moon of December 27–28, made at the Observatory of Bordeaux, made by MM. G. Rayet, E. Doublet, and F. Courty, by M. G. Rayet.—Report on a memoir of M. Partiot on the choice of a velocity formula.—Generalisation of the analytical prolongation of a function, by M. Eugene Fabry.—On the singular points of a function defined by a Taylor's series, by M. Servant.—On the correspondence between right lines and spheres, by M. E. O. Lovett.—On the bending of a cylinder with circular base, by M. Ribière.—On the experiment of Lord Kelvin and Joule, by M. A. Leduc.—On the variations of resistance of an electrolytic conductor in a magnetic field, by M. H. Bagard. The author has succeeded in showing that the resistance of a solution of copper sulphate, suddenly placed in a magnetic field of about 5000 C.G.S. units, undergoes an increase of about one per cent. its original value.—On the absolute value of the magnetic elements on January 1, 1899, by M. Th. Moureaux.—On the preparation and properties of calcium arsenide, by M. P. Lebeau. This

substance can be obtained in a state of purity in two ways, by the interaction of calcium and arsenic at a low red heat, and by heating carbon and calcium arsenate in the electric furnace. The arsenide has the composition Ca_3As_2, and is readily decomposed by water giving pure AsH_3, mixed, however, with a little acetylene when the product from the electric furnace is used. It is readily attacked by the halogens, but is unaltered in dry air or oxygen.—On the decomposition of carbon monoxide in presence of ferric oxide, by M. O. Boudouard. The decomposition is a function of the time, and also depends upon the quantity of oxide of iron present.—Volumetric estimation of cerium, by M. André Job. Ceric salts can be accurately determined in acid solution by titrating with aqueous hydrogen peroxide, the end of the reaction being indicated by the disappearance of the yellow coloration. An estimation of the cerium contained in the crude mixture of oxalates from monazite can be carried out in a few minutes by this method.—The variation of entropy in the dissociation of similar heterogeneous systems, by M. Camille Matignon. From the measurements of MM. Isambert and Bonnefoi of the heats of combination and the temperatures at which the dissociation pressure reaches 760 mm., it is shown that these quantities are proportional in the case of compounds of the type $CaCl_2 4NH_3$. This result is expressed by the statement that when similar systems dissociate with the same dissociation pressure, the variation of entropy is the same.—Constitution and chemical properties of ethylideneimine, by M. Marcel Delépine. The constitution ethylideneimine $(CH_3CH=NH)_3$, is assigend to aldehyde ammonia, and it is shown that all the reactions of this compound agree well with the formula.—Derivatives of synthetic methyl-heptenone, by M. Georges Leser.—Synthesis of dimethyl-heptenol, by M. Ph. Barbier. This synthesis is easily effected from methyl-heptenol and methyl-iodide, by a modification of Saytzeff's method, using magnesium instead of zinc.—Studies on filtration, by M. J. Hausser.—On a mode of formation of ureas, by M. A Jouve. If a solution of carbon monoxide in ammoniacal cuprous chloride is heated under pressure at 105°, urea is formed. The substitution of fatty and aromatic amines for the ammonia gives the analogous substituted ureas.—On an absinthine, a new substance extracted from absinthe, by MM. Adrian and A. Trillat.—On the formation of sugar from egg albumen, by M. Ferdinand Blumenthal. By the action of baryta water upon white of egg, a sugar is obtained giving a phenyl-glycosazone on treatment with phenyl-hydrazine.—Modifications undergone by toxins when introduced into the digestive tube, by MM. Charrin and Levaditi.—The sexual law of the smallest coefficient, by M. F. Le Dantic.—On the culture of monstrosities in plants, by M. Hugo de Vries.—The leucite volcanic rocks of Trebizonde, by M. A. Lacroix.—On the laws governing macles properly so called, by M. Fred. Wallerant.—On the conditions of culture in Tunis, by M. J. Dybowski.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 19.

ROYAL SOCIETY, at 4.30.—Observations upon the Normal and Pathological Histology and Bacteriology of the Oyster: Prof. Herdman, F.R.S., and Prof. R. Boyce.—On the Formation of Multiple Images in the Normal Eye: S. Bidwell, F.R.S.—On the Vibrations in the Field round a Theoretical Hertzian Oscillator: Prof K. Pearson, F.R.S., and Miss Lee.—On the Refractive Indices and Densities of Normal and Semi-normal Aqueous Solutions of Hydrogen Chloride, and the Chlorides of the Alkalies: Sir J. Conroy, F.R.S.

ROYAL INSTITUTION, at 3.—Tibet and the Tibetans: A. H. Savage Landor

SOCIETY OF ARTS (Indian Section), at 4.30.—Railways in Burma, and their proposed Extension across Yunnan: J. Nisbet.

LINNEAN SOCIETY, at 8.—New Peridiniaceæ from the Atlantic: G. R. Murray, F.R.S., and Miss F. G. Whitting.—On the Structure of Lepidostrobus: Arthur J. Maslen.—Some Observations on the Caudal Diplospondyly of Sharks: Dr. W. G. Ridewood.

CHEMICAL SOCIETY, at 8.—Researches on Moorland Waters. I. Acidity: W. Ackroyd.—a-ketotetrahydronaphthalene: Prof. F. S. Kipping, F.R.S., and Alfred Hill.—A New Method for preparing *as*-dimethyl- and Trimethyl-succinic Acids: William A. Bone.—Reduction of Optically-active Mono- and Di-alkyloxysuccinic Acids from Malic and Tartaric Acids: Prof. Thomas Purdie, F.R.S., and William Pitheathly.—Action of Ammonia on Ethereal Salts of Organic Bases: Dr. Siegfried Ruhemann.—Esterification Constants of Substituted Acetic Acids: Dr. J. J. Sudborough and Lorenzo L. Lloyd.—Di-ortho-substituted Benzoic Acids. Part IV. Formation of Salts from Di-ortho-substituted Benzoic Acids and different Organic Bases: Lorenzo L. Lloyd and Dr. J. J. Sudborough.—The Thermal Effects of Dilution: J. Holmes Pollok.—The Changes of Volume due to Dilution of Aqueous Solutions: F. B. H. Wade.

FRIDAY, JANUARY 20.

ROYAL INSTITUTION, at 9.—Liquid Hydrogen: Prof. J. Dewar, F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Epidemic Cerebro-spinal Meningitis: Dr. Bruce Low.

QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, JANUARY 21.

MATHEMATICAL ASSOCIATION, at 2.—Annual Meeting.—On the Expression "Motion at an Instant": S. A. Saunder.—Porismatic Equations: R. F. Davis.—Arithmetical Division: E. M. Langley.

MONDAY, JANUARY 23.

SOCIETY OF ARTS, at 8.—Bacterial Purification of Sewage: Dr. Samuel Rideal.

IMPERIAL INSTITUTE, at 8.30.—The Work and Wealth of Western Australia: E. T. Scammell.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Plan of the Earth, and its Causes: Dr. J. W. Gregory.

TUESDAY, JANUARY 24.

SOCIETY OF ARTS (Foreign and Colonial Section), at 4.30.—Rhodesia and its Mines: W. Fischer Wilkinson.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Effects of Wear upon Steel Rails: William G. Kirkaldy.—On the Microphotography of Steel Rails: Sir William Roberts-Austen, K.C.B., F.R.S.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The Development of Gelatino-chloride Papers: John Sterry.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Anniversary Meeting.

WEDNESDAY, JANUARY 25.

SOCIETY OF ARTS, at 8.—Tuberculosis in Animals: W. Hunting.

THURSDAY, JANUARY 26.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Contributions to the Theory of Simultaneous Partial Differential Equations: Prof. A. C. Dixon.—On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks. III. On *Medullosa anglica*, a New Representative of the Cycadofilices: Dr. Scott, F.R.S.—On the Nature of Electro-Capillary Phenomena. I. Their Relation to the Potential Differences between Solutions: S. W. F. Smith.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains: J. Pigg.—The Regulation of Wiring Rules: C. H. Wordingham.—The Institution Wiring Rules: R. E. Crompton.

CONTENTS.

THURSDAY, JANUARY 26, 1899.

THE PHYSIOLOGY OF MAN AT HIGH ALTITUDES.

Life of Man on the High Alps. By Angelo Mosso. Translated from the Second Edition of the Italian by E. Lough Kiesow. Pp. xv + 342. (London: T. Fisher Unwin, 1898.)

The Annals of Mont Blanc. By Charles Edward Mathews. Pp. xxiv + 368. (London: T. Fisher Unwin, 1898.)

THE modifications which are produced in the organism by residence at great heights differ in many respects from those witnessed in laboratory experiments where men or animals are subjected to diminished pressures in a pneumatic chamber. For this reason the observatories and huts on Mont Blanc and Monte Rosa have during the last few years afforded a shelter to several physiologists, and the results of a most extensive series of researches which were carried out in the Regina Margherita hut on Monte Rosa, at a height of 14,592 feet, are to be found in the "Fisiologia dell 'uomo sulle Alpi," by Prof. Angelo Mosso of Turin. This volume stands alone in scientific Alpine literature. It is the first attempt that has been made to present the various complex physiological phenomena which man exhibits at high altitudes, in such a form as to be easily understood by those who are not trained physiologists. Whether this attempt has been entirely successful is a matter of some doubt. It is a much better book than that of D. Jourdanet, on the "Influence de la pression de l'air sur la vie de l'homme," a huge volume of over 600 pages, which treats of the same subject.

The book is well translated, and it is seen that Prof. Mosso has carried out his researches with special physiological apparatus, some of which was designed for the particular study of man at high altitudes. The book contains some excellent tracings, which record the pulse and heart-movements. Records of the cerebral pulse taken with Marey's tambour, and of the blood-pressure in the limbs obtained with the plethysmograph are also given. Using Bianchi's phonendoscope, Prof. Mosso obtains some figures which are rather alarming to look at, showing that there is a normal physiological dilatation of the heart during a mountain ascent; after exercise the left side of the organ is enlarged, and in one figure the apex is displaced downwards, in the other the displacement is upwards. Many tracings were taken of the respiratory movements, and one of the most interesting is a record of the onset and culmination of a fainting fit. Phasic respiration or Cheyne-Stokes breathing is common at great heights, and especially well seen during sleep; complete cessation of movement for as long as twelve seconds separated the respiratory phases in the case of U. Mosso. The respiratory organs also tend to pause at the end of expiration. It is a well-recognised fact that the stature diminishes during the day, but a mountain ascent may produce such a flattening of the lumbar curve that a man may be an inch and a half shorter when he reaches the summit of Monte Rosa than he was in the plains.

Enough has been said to show that this book is of great interest, and since it is possible that the great authority of Prof. Mosso, who is well known in this country as a distinguished physiologist, may cause this volume to be regarded as the standard work on the physiology of man at great altitudes, it is necessary to point out some of the very unexpected facts which are stated, and remarkable theories which are advanced by Prof. Mosso, although the very discursive way in which the whole book is written makes this a matter of some difficulty. This volume is really neither a popular nor a scientific study of the phenomena of life at high levels. It is partly the one and partly the other. It is impossible from the information which is given to judge of the correctness of several of Prof. Mosso's views; and with a full knowledge of the exceedingly laborious work which was carried on for some weeks in the uncomfortable surroundings of an Alpine hut, it is a matter of regret to have to say that some of the results carry but little conviction to the mind of a physiologist, while those who are not in a position to weigh the evidence that is given, may make the mistake of imagining that many questions of great difficulty and complexity have been finally answered.

At an altitude of 14,800 feet, Prof. Mosso states that much more work can be accomplished than at the sea-level, and also that there is no increase in the frequency of respiratory movement; indeed, both the frequency and amplitude may be diminished, or with a frequency exactly like the normal the amplitude may be less. This phenomenon is certainly unexpected, and so is the remarkable statement that on the summit of Monte Rosa the rate of breathing was not always altered even by fatiguing muscular work. Mosso has shown that on the plains there is a *luxus-respiration*, the organism takes in a quantity of oxygen which is more than sufficient for its immediate needs; at a great height the breathing is not augmented, since though less oxygen is actually consumed it is enough, but not more than enough, for the needs of the organism. It has, however, been proved by actual experiments on mountains that when a height of only 8900 feet is reached, even at rest there is a slight increase in the gas exchanges and in the rate of breathing; while at 14,800 feet there is a great increase in both of these, indicating that whatever may be the cause there is a marked rise of metabolism at a diminished pressure of 425 mm. Prof. Mosso refers to these experiments, which were made by the brothers Loewy and Leo Zuntz, but they do not, of course, support his views on mountain-sickness. On p. 192 mention is made of the observations of Benedicenti on combustion in rarefied air. Prof. Mosso regards these "as intimately connected with the study of respiration in the Alps because, since the celebrated experiments of Lavoisier, it is a well-known fact that breathing in many respects resembles combustion." This analogy is entirely misleading, for the whole process of respiration, either internal or external, is exactly the reverse of combustion. The consumption of oxygen by an organism is wel known to be dependent not on the amount of this gas

which is available, but on the necessities of the animal; variations between 12·5 and 60 per cent. of oxygen have scarcely any influence on the magnitude of the gas-exchanges in respiration.

Though most of the evidence in this book is not in favour of the idea that there is an anoxyhæmic condition of the blood at great altitudes, the new theories which are advanced can only be accepted when more experimental work has been accomplished. As to the changes in the blood on the Alps, on the question whether the undoubted increase in number of red corpuscles is real or apparent, Prof. Mosso is in accord with many physiologists in considering that the cause of the variations lies in the climatic conditions, in the more active influence of the sun's rays, in the greater dryness of the air, and in the altered mode of life. His own observations on this subject, which is one of the greatest interest, are open to the objection which may be taken to so many of the facts in this book, that the method of conducting the experiments is described, but the description is insufficient to enable a fair criticism to be made as to the value of the work. His contention that if Suter found an increase of 6·4 per cent. in the number of red corpuscles at a height of 1300 feet, the blood of those on Monte Rosa should show an increase of 64 per cent., which he regards as absurd, might possibly be found to be the case, since Viault's figures for a lower level showed an increase of 3,000,000 corpuscles per cubic millimetre of blood.

The cause of mountain-sickness is maintained by Prof. Mosso to be due to an actual diminution in the quantity of carbonic acid in the blood, the theory of *acapnia*, which assumes that this gas is the normal exciting agent for causing a discharge from the nerve-cells in the medulla oblongata. Mountain-sickness is in fact an asphyxia that is dependent not upon want of oxygen, but on a want of carbonic acid. He affirms that mountain-sickness is generally worse at night, and that this is due to a diminished production of carbonic acid when a man is at rest. The experience of many climbers is the contrary; mountain-sickness may occur quite suddenly during an ascent. There are members of the Alpine Club who have never reached the summit of Mont Blanc even after repeated attempts; a limit of 13,000 feet on this mountain cannot be passed without exceeding distress. The same individuals can, however, reach the summit of Monte Rosa. That there is really a deficiency of carbonic acid in the blood at great heights is most difficult of proof. Prof. Mosso refers to the analyses of the blood-gases made by Fraenkel and Geppert in 1883, and though these may show a slight decrease in the amounts of the carbonic acid, the differences are almost within the limits of experimental error. There is no fixed figure which decisively gives the actual amount of this gas in the blood. At the sea-level the amount of carbonic acid in arterial blood of the same species of animal may vary from 42·63 to 23·9 per cent. or from 53·4 to 23·3 per cent. If Prof. Mosso uses selected cases from Fraenkel and Geppert's tables in order to strengthen his position, it may be pointed out that their analyses show that with a rarefied atmosphere corresponding to 23,000 feet, the blood may actually contain more carbonic acid than at the sea-level. Even if it could be shown by data far more convincing than those given by Prof. Mosso, that there is an alteration in the output of carbonic acid at great heights, we should not be justified in regarding this as evidence of an alteration in the carbonic acid of the blood. To advance one hypothesis against another, it is conceivable that since an organism with excess of carbonic acid in the blood strives to eliminate this by increased frequency of breathing, an organism that possesses less of this valuable gas in its blood would tend to preserve a constant percentage in this liquid by exhaling, first of all, a less amount, and perhaps at last hardly any of the gas, in the same way as an animal is known to preserve the proteid constituents of its body at the expense of the fats and carbohydrates during starvation.

In the experiment on p. 298, where it is shown that the effects of diminished pressure may be counteracted by administration of air with 16·7 per cent. of carbonic acid, there would appear to be an error, for if the gas-mixture was made as is described, the original air of the laboratory must have contained 8 per cent. of carbonic acid. As to the action of this gas on the organism, according to Prof. Mosso's experiments, it essentially produces a slackening of the cardiac movements, which is seen not at the sea-level, but when the organism is subjected to the action of rarefied air. It may be admitted that there is a prompt reaction to a slight increase of carbonic acid in inspired air, and comparatively none to the same proportional diminution of oxygen, but since it is not possible to show that a slight excess or diminution of oxygen in inspired air is followed by any excess or diminution of this gas in the blood, it is probable that the effect of an increase of carbonic acid in inspired air acts in a reflex manner, and not by an action on some part of the central nervous system after it has been absorbed by the blood. That definite constriction of the bronchioles occurs as the result of a reflex action after the inhalation of small percentages of carbonic acid is a well-established fact, and there is every probability, or at any rate the possibility, which Prof. Mosso does not discuss, that an increased percentage of carbonic acid acts in a similar way. In the pneumatic chamber Prof. Mosso has succeeded in withstanding a rarefaction of the air when the barometer stood at 192 mm. This corresponds to an altitude of 37,862 feet. At the commencement of the experiment the pressure was 742 mm. After about an hour, when the pressure is 292 mm., oxygen is inhaled by allowing about 100 litres of the gas to enter the pneumatic chamber. The pulse rate has fallen below the normal, the heart beats 64 per minute, and the rate of respiratory rhythm is 19. Half an hour later, at a pressure of 192 mm, the pulse is 84 and respiration 18. The oxygen percentage by weight in the chamber at 292 mm. was 8·45 before oxygen was allowed to flow in, and 8·14 parts by weight when the pressure had fallen to 192 mm. The air of the chamber now contained 2·1 per cent. of carbonic acid, but contained only ·8 per cent. of this gas when the pressure was 292 mm. Prof. Mosso's interpretation of this interesting experiment is that he sustained a diminution of pressure from 292 to 192 mm., on account of the presence of this 2·1 per cent. of carbonic acid. Though he admits that

oxygen has a distinctly beneficial action in reducing the frequency of the heart-beats, he considers that the increased percentage of carbonic acid in the inspired air prevented asphyxia, or using his own term *acapnia*, a condition which can be set aside by a high percentage of carbonic acid, since the barometric depression acts in a mechanical and physical manner by drawing this gas out of the blood. It may be pointed out that it is evident that Prof. Mosso's experiment might well bear another explanation, for it does not show more than that the respiration of an atmosphere containing 8·4 per cent of oxygen is sufficient for the needs of a man during a short period. Diminution of the carbonic acid of the blood, and a paralysis of the terminations of the vagi nerves will, according to Prof. Mosso, account for the headache, dizziness, vomiting, and other symptoms which are noticeable in mountain-sickness, whether this is met with in a slow or an acute form. Vomiting is undoubtedly a frequent symptom, but that this is caused by paralysis of the vagi nerves is not in complete accord with experimental evidence. The ease or difficulty with which this act is accomplished varies in different animals, and it is found that severing the vagi produces variable results; vomiting may occur, but often does not, and further vomiting is asserted not to occur at all after section of these nerves. Some physiologists, such as Bernstein, distinctly state that the vagus plays no essential part in the nervous mechanism which is concerned in vomiting. On p. 258 the distress of angina pectoris is regarded as resembling the distress of mountain-sickness. This appears to be hardly the case; certainly vomiting is not, as Prof. Mosso distinctly states it is, a characteristic symptom of angina pectoris.

No doubt Prof. Mosso may adduce some additional evidence in support of his views. Most physiologists attribute the excitation of nerve centres rather to the lack of oxygen than to the presence of carbonic acid. We must expect analyses of the blood gases to be given, which shall definitely show that a diminished barometric pressure is associated with a constant diminution of carbonic acid in the blood, and, further, it must be shown that an atmosphere with increased percentages of carbonic acid causes the blood to take up and retain this gas, before it can be admitted that Prof. Mosso's theory of *acapnia* has solved the problem of mountain-sickness.

In "The Annals of Mont Blanc," by C. E. Mathews, a volume which is beautifully printed, and contains excellent illustrations, an historical account of the ascents of this mountain is given. In this work an attempt is made to rehabilitate the reputation of Dr. Paccard, who made the first ascent with Balmat. The rival merits of these two pioneers is discussed, and the hope expressed that tardy justice may yet be made to Dr. Paccard. A very graphic and interesting account is given of the caravan of about forty people which started off in 1851 with Albert Smith, whose subsequent entertainment with Beverley's panorama at the Egyptian Hall may, in a sense, be considered to have introduced the beauties of the Chamonix valley to the attention of Englishmen. It is said that every one climbs Mont Blanc now; men have climbed it without guides; women have climbed it; blind men have reached the summit. With two observatories close to the summit, those of Vallot and Janssen, the mountain may almost be regarded as having become inhabited. The chapter on the geology of Mont Blanc is contributed by Prof. T. G. Bonney. The volume also contains a bibliography of Mont Blanc, and an appendix with good facsimiles of the "Glacieres in Savoy," published in 1744. G. A. B.

GERMAN CHINA—TWO BOOKS ON SHANTUNG.

Schantung und seine Eingangspforte Kiautschou. Von Ferdinand Freiherr von Richthofen. Mit 3 grossen Karten ausser Text. Pp. xxviii + 324. (Berlin: Dietrich Reimer (Ernst Vohsen), 1898.)

Schantung und Deutsch-China. Von Kiautschou ins Heilige Land von China und von Jangtsekiang nach Peking im Jahre 1898. Von Ernst von Hesse Wartegg. Pp. viii + 294. (Leipzig: J. J. Weber, 1898.)

FROM the period of the Jesuit missionaries of the seventeenth century until the present year the bibliography of the Chinese province of Shantung could be printed in a dozen lines; but in the immediate future a flood of Shantung literature will form a conspicuous part of the impending deluge of books on China. The beginning is before us in these richly illustrated volumes, one the work of the most thorough scientific explorer who ever visited China, the other the impressions of a champion globe-trotter. Both books owe their appearance to the lease of Kiauchou Bay recently acquired by the German government, along with extensive rights for the development of the Shantung peninsula. The two prefaces are characteristically in contrast. Baron von Richthofen cautions his readers as to the extreme paucity of trustworthy information, and details the sources whence it can be obtained. The Chevalier von Hesse Wartegg explains that he hastily resolved to see this province for himself, and claims to have visited every place and seen everything in it of any interest whatever to the German public, and all in an amazingly short space of time. The books themselves amplify the contrast. Baron von Richthofen gives an account of his leisurely journey of thirty years ago with the valuable maps which he constructed, and a solid description of the physical structure and economic resources of the province, which, while it will certainly soon be greatly added to by practical explorers, cannot easily be superseded. Von Hesse Wartegg recounts his travels in a gossipy manner, interspersed with notes on the country and people, and copiously illustrated with a wealth of photographs, facsimiles of Chinese proclamations, visiting cards, official stamps and such interesting trifles. He caught the new German territory at the beginning, and describes that beginning with an elaboration of detail which should not weary the patriotic German reader. The rapidity of the journey necessarily detracts from the permanent value of the descriptions of the various towns and places visited, and the work must be looked upon as a sort of "Christmas number" amongst books of travel.

Baron von Richthofen's book merits some furthe

notice. Much of it has been published before in the first two volumes of his monumental work on China, the size and price of which have made it a sealed book to most commercial Germans, and the language has presented an even more serious obstacle to the vast usefulness which it should have for the British merchant and student. Parenthetically one cannot help remarking how much an English publisher could serve the interest of his country by producing translations of such works as Richthofen's "China," and resolutely rejecting the sensational jottings of uninstructed tourists, whose writings it is a dreary and discouraging task merely to glance through and throw aside. While the German bar remains to exclude English readers of the class who could most profit by it, the handy form and low price of the new volume will be highly appreciated in Germany. The fact that Baron von Richthofen recognised Kiauchou Bay thirty years ago as a desirable base for German colonial enterprise, is a striking example of the practical value of expert opinion, even though a government be long in acting upon it.

The book contains a valuable introduction dealing with points of practical importance for all interested in China. The section on the European orthography of Chinese names is of great value, and, making allowance for the slight differences in phonetic expressions in German and English, it is no less useful for us than for our neighbours across the North Sea. Baron von Richthofen points out that all Chinese names are made up from a collection of 330 syllables, each represented by a single ideograph which does not vary, although the phonetic and tone value of it differs in each provincial dialect. But while the natives of distant provinces cannot understand each other's speech, they can all not only read the ideographs, but can understand an educated Chinaman speaking the Mandarin dialect—High Chinese, as Richthofen terms it in order to work out a pretty analogy between Chinese and the High German and various local dialects of his Fatherland. All that has to be done is to discover the normal phonetic value of each syllable in "High Chinese," and adopt a definite spelling for it, and the names of all China can then be written with confidence. This, of course, is not published for the first time; but it may be appropriately referred to at present in reference to the adoption in the publications of the Royal Geographical Society of such spellings as *Yang-tse-Chiang* in accordance with Sir Thomas Wade's system of selecting the Peking dialect as the basis for phonetic rendering, whereas the form *Yang-tse-kiang* is the normal one. As so much will be written on China and Chinese affairs in the immediate future, it is really an urgent matter to scientific men, as as well as to merchants and journalists, to fix upon some one mode of spelling which will facilitate reference and prevent confusion. The German forms of Von Richthofen can be adopted in every particular except that where it has *sch* we must write *sh*, and where it has *tsch* we must write *ch* simply. The Germans have adopted *y* in place of their *j*, have the *s* always sharp, and discard the German *z* in favour of *ts*, and they have received the *j* with its French (our *zh*) sound, and the *w* with its English value.

A note on the various grades of Chinese towns explains the meaning of the *-fu*, *-chou*, and *-hsien* attached to the significant part of the name. There is a useful section on weights and measures, in which, however, an error of a decimal point occurs, the length of the *chih* or Chinese foot being given as 3·581 metres according to the British Commercial Treaty. That treaty, however, specifies 14·1 inches as the length of the *chih*, *i.e.* 0·358 metre.

AUSTRALIAN FOLK LORE.

Australian Legendary Tales. Collected by Mrs. K. Langloh Parker. With introduction by Andrew Lang. Pp. xvi + 132. (London: Nutt. Melbourne: Melville, Mullen, and Slade, 1897.)

More Australian Legendary Tales. Pp. xxiii + 104. (London: Nutt. Melbourne: Melville, Mullen, and Slade, 1898.)

AUSTRALIA is still in many respects an unknown country, full of unravelled problems, not the least amongst them being the people who were once the owners of the land. Bit by bit we are getting to know something about the continent, its geology, fauna, and flora; but of its people, beyond their language and physique and complex marriage laws, we know little, and especially is this the case regarding their psychology. This is much to be regretted; but the seeds of the neglect were sown when the first Colonial governments began to sell lands, not their own, to the squatters and settlers to stock with sheep and cattle or for cultivation. But the sheep and cattle ate up the foods which had hitherto been the support of the fauna, upon which the aborigines relied largely for sustenance, so that before long the flocks and herds of the invaders were killed by the hungering natives. The stock-riders and shepherds left to guard the flocks were attacked with a boldness born of ignorance, and reprisals followed with a wantonness and cruelty we would gladly shut our eyes to. In the end the weaker party succumbed and degenerated as we see them in the smaller township of the bush, breeding an undeserved contempt in the minds of their despoilers. Any intercourse of an elevating nature with the Australian was thus nipped at the outset, and hence it is we know so little of the inner life of the doomed people. Fortunately, of late years many good attempts have been made to rescue from loss a very considerable knowledge of the natives, and we have now to record a further attempt, resulting in the publication of two charming volumes, for which we must express our gratitude to the author. For twenty-five years Mrs. Parker has studied the aborigines on the Narran River in New South Wales, close to the Queensland border, discovering practically a new field, for it is the first collection of Australian aboriginal legends we have had the good fortune to meet with. A large number of the stories explain the origin of things according to the native mind—why the cockatoo is bald under his crest, and the lizard covered with prickles; how fire was discovered and stolen; how the Narran lake (? swamp) first made its appearance; and how it is that the pelican has a pouch; how the platypus came to be a cross between a duck and a rat. Much also do we gather about the daily life of the natives: how they prepare their food, hunt the emu, carry on war, and make rain—which latter is

sometimes evoked to drown their enemies. In these legends there are ogres and ogresses, who meet with summary justice—some being destroyed by their own means of destruction; human folk climb into the sky as a place of refuge, others are carried there and become stars, some are turned to stone, others see through their noses; their dream spirits get stolen, and one gentleman, to prevent its leaving him, sleeps on his stomach, so that it should not escape from his mouth; there are even underground passages and a moral story, a fragment, of the flies and the bees, which reminds us of the ant and the grasshopper. Poetical justice, too, is not wanting, and in the plan by which Deereeree frightened the widow into marrying him there is a touch of humour. Full of feeling are many of the stories. When the wicked magpie stole the children, "their crying reached the ears of the women as they were returning to their camp. Quickly they came at a sound which is not good in a mother's ears." The legend of Sturt's Desert Pea, the Flower of Blood of the old tribes (*Clianthus Dampieri*), which, when once seen in its rich clusters is never forgotten, is worth reproducing.

Wimbakobolo, a warrior, falls in love with Purleemil, who is otherwise betrothed to the hated Tirlta, and the two take refuge with a friendly tribe. Before the winter had gone a son was born to them, and such a fine little fellow was he that "the tribe laughingly called him 'the little chief,' and brought him offerings of toy boomerangs, throwing-sticks, and such things until the eyes of his mother shone with pride, and the father already began to make him weapons, to be used one day against the enemies of the tribe who had sheltered them. And Purleemil sang new songs, which she said the spirits taught her, about her little son, whom she said was to live for ever, the most beautiful on the plains of the back country. Purleemil would sing her songs, and her baby would crow and laugh, and the father would say little, but bear so proud a look on his face as he glanced, from his carving of weapons with an opossum's tooth, from time to time at his wife and child, that all would smile to see his happy pride, and their hearts were glad that the elders had not given up Purleemil to be the bride of Tirlta." Then the mother, fearing trouble to themselves and 'little chief,' says: "Dark would our lives be without him; he is the sun that brightens our days; without him dark as a grave would they be for ever." But the trouble does come. A night attack is followed by a general massacre. Little chief and his parents are slain, and from their blood arise masses of brilliant red flowers spreading over all. Tirlta revisits the spot to gloat over the slain, and is dazed by the sight before him. Suddenly from the sky a spear transfixes him, and a voice says: "Cowardly murderer of women and children; how dare you set foot on the spot made sacred for ever by the blood that you spilt, the blood of the little chief, his mother and father, which flowed in one stream and blossomed as you see it now, for no man can kill blood, for more than the life of the flesh is in blood. Their blood shall live for ever, making beautiful with its blazing brightness the bare plains, where are the salt lakes, the dried tears of the spirits whose songs Purleemil sang so sweetly, the salt tears which they shed when you, and such as you, poured out the life blood of their loved tribe." So Tirlta was transfixed and turned to stone, but the beautiful red flower lives for ever.

When once it is known that such pretty legends are to be gathered from amongst the Australian natives, there is little doubt but that other friendly squatters and officials will attempt to follow in Mrs. Parker's footsteps. In the meanwhile her two little volumes will certainly run into further editions; and such being the case, we would point out that there are several printer's errors, and that the glossary, excellent as it is, requires further additions. It is doubtful whether an average English reader will know what is meant by a "paddymelon" or a "humpy"—regarding the former word in the story of Mayamah, the printer has placed a comma between paddy and melon! The book is illustrated by some curious sketches made by an untaught local aborigine, supplied by Dr. W. H. Lang of Corowa, about three hundred and sixty miles distant from the Narran. May we ask, did this native ever see any European illustrations before he took to book illustration? Mr. Andrew Lang supplies a preface to each of the two books, in his usual happy strain.

H. Ling Roth.

OUR BOOK SHELF.

The Five Windows of the Soul; or, Thoughts on Perceiving. By E. H. Aitken. Pp. viii + 257. (London: John Murray, 1898.)

Readers of former books by "EHA" will turn with a sense of pleased anticipation to a new work from his pen. They know that they may expect to find a fresh and unconventional setting-forth of various matters of scientific interest, expressed in terse and vigorous English, illuminated by flashes of genuine humour, and accompanied by such comments on the relation of natural phenomena to the ordinary facts of life as suggest themselves to the shrewd intellect of a well-read philosopher and cultivated man of the world. Nor will the present work belie expectation. It is a popular treatise on the five senses—popular in the best acceptation of the word—for it is at once amusing without flippancy, instructive without dulness, and accurate without pedantry. The author has taken evident pains to gather the best and latest information on the subject of the organs of sense; and although it might be possible in a spirit of hypercriticism to point out certain errors and deficiencies, he has in the main succeeded so well that his work ought to mark a distinct epoch in the history of general comprehension and appreciation of the subject. In dealing with the various trains of thought suggested to him by the scientific facts in question, and involving problems of the greatest interest in æsthetics and ethics, he reaches and maintains a high level of literary and philosophical excellence. We should like to commend the whole book, and especially the fourth chapter, to the attention of certain puritan fanatics.

One piece of criticism we must allow ourselves. Mr. Aitken, it is true, could hardly be expected to have made himself acquainted, in time for the production of his book, with the recent striking interpretation of the gradual paling of colour on the under parts of animals. But in some other respects his treatment of the subject of colour is not thoroughly satisfactory, and on p. 219 he seems to steer dangerously close to the "photographic" heresy. Slight blemishes such as these do not, however, detract seriously from the value of a work which represents the honest and successful endeavour of one who is not a professed scientific worker to "see life steadily and see it whole" in its relation to the entire domain of natural knowledge.

F. A. D.

Symbolae Antillanae: seu Fundamenta Florae Indiae Occidentalis. Edidit Ignatius Urban. Vol. i. Fasc. 1. Pp. 192. (Berlin: Friedländer, 1898.)

SINCE the publication of Grisebach's "Flora of the British West Indian Islands" in 1859–64, large additions have been made to our knowledge of the native plants, not only of our own West Indian islands, but also of those belonging to other countries. The distinguished Curator of the Imperial herbarium at Berlin has contributed much to this knowledge, but in the form of papers scattered through a number of botanical publications. These he now proposes to collect, and to publish in a connected form, together with hitherto unpublished descriptions of new genera and species, &c. The first instalment, of 192 pages, is occupied entirely with a bibliography of West Indian botany, every work being mentioned which furnishes any information on the native products of the West Indies, whether phanerogamic or cryptogamic, with, where possible, an account of its contents. Every one who has worked at local floras will know how work of this kind is facilitated by a good bibliography; and the thanks of systematic botanists are due to Prof. Urban for the thoroughness with which he has executed this task.

Iowa Geological Survey. Annual Report, 1897, with accompanying papers. Vol. viii. Dr. Samuel Calvin and H. F. Bain. Pp. 427. (Des Moines, 1898).

A LARGE part of this volume is taken up with reports on the geology of Dallas, Delaware, Buchanan, Decatur and Plymouth counties, Iowa. With the survey work referred to, the survey and mapping of twenty-six counties in the State have been completed. In addition to this areal work, special studies of coal, clay, artesian waters, gypsum, lead, zinc, &c., have absorbed a considerable portion of the funds and time of the Survey. As in previous years, close attention was given to the study of problems connected with the drift, and very gratifying progress was made. A paper by Mr. H. F. Bain, Assistant State Geologist, on properties and tests of Iowa building stones, contains much instructive information concerning building stones in general, as well as results of tests of Iowa stones.

In concluding his summary report, Dr. Calvin remarks: "It is gratifying to note the increased use of the reports of the Survey, as works of reference, or works for general study, in high schools and other educational institutions. Progressive teachers have been quick to recognise the educational value of trustworthy tests relating to the physical geography and geological phenomena of regions with which the students are personally acquainted." The reports are thus performing a mission of great educational value to the State.

Numerous plates and half-tone illustrations accompany the papers in the report.

Elementary Mathematics. By J. L. S. Hatton, M.A., and George Bool, B.A. Pp. viii + 356. (London: Whittaker and Co., 1898.)

IT is not often that arithmetic, Euclid, and algebra, are dealt with in a single text-book, and the only reason for their joint appearance in the present volume, is that students working in classes examined by the Science and Art Department may have at hand a means of qualifying themselves for the May examination in Stage I. Mathematics. A knowledge of the fundamental rules of arithmetic is assumed, but numerous examples are given upon them. The Euclid embraces the first Book, with a few additions; and the algebra extends to problems involving simultaneous equations. If only a small proportion of the examples is worked by the student, the dexterity required to pass the examination for which the book is intended will be obtained.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Prof. Meldola's Explanation.

I AM obliged by the courteous expressions of Prof. Meldola's letter, and regret that I should have given him the trouble of writing the latter part of it by not quoting in full a certain passage which I quoted in part: a deficiency of quotation caused by the wish to occupy as little space as possible. As evidence of change in my views, Prof. Meldola takes from "The Factors of Organic Evolution" the following passage:—

"Eventually, among creatures of high organisation, this factor [inheritance of functionally-wrought changes] became an important one; and I think there is reason to conclude that, in the case of the highest of creatures, civilised men, among whom the kinds of variation which affect survival are too multitudinous to permit easy selection of any one, and among whom survival of the fittest is greatly interfered with, it has become the chief factor: such aid as survival of the fittest gives, being usually limited to the preservation of those in whom the totality of the faculties has been most favourably moulded by functional changes" (p. 74).

I now give at length the corresponding passage from the first edition of the "Principles of Biology."

"As fast as the number of organs that co-operate in any given function increases, indirect equilibration through natural selection becomes less and less capable of producing specific adaptations; and remains fully capable only of maintaining the general fitness of constitution to conditions. Simultaneously, the production of adaptations by direct equilibration, takes the first place—indirect equilibration serving to facilitate it. Until at length, among the civilised human races, the equilibration becomes mainly direct: the action of natural selection being restricted to the destruction of those who are constitutionally too feeble to live, even with external aid."

It will be seen that there is no difference between the two, save in form of expression. My belief remains just what it was in 1864.

I suspect that the erroneous impression Prof. Meldola refers to resulted mainly from the ill-judged title "The Inadequacy of Natural Selection." I meant simply to imply that natural selection does not explain all the facts. A better title would have been "Natural Selection a part cause only."

Brighton, January 22. HERBERT SPENCER.

Illusory Resolutions of the Lines of a Spectrum.

DR. PRESTON, in his useful article on Zeeman's phenomenon in NATURE of the 5th inst., has expressed the opinion that some of the resolutions of spectral lines obtained by Michelson's interferometer are illusory (see p. 228). I had occasion some months ago to make use of some of Michelson's results, and came to the same conclusion. In fact, an instrumental resolution of what is in reality a single line may cause it to assume appearances, the principal of which are either a central line with faint appendage lines, or a double line with appendages.

I. *Central line and appendages.*—Let us first consider the illumination produced in the first spectrum by a parallel beam of monochromatic light incident on a grating with $n + 1$ parallel grooves, furnishing n equal and equally spaced reflecting strips between the grooves. This produces in the first spectrum what is usually regarded as a line in a position which we may call A, but what is really a distribution of light along the whole spectrum, having (if the slit be of infinitesimal width) positions of cypher intensity at short intervals, and having a maximum of illumination between every two consecutive positions of cypher intensity.[1] The intensities of these maxima are such that one of

[1] If the light is incident perpendicularly on a flat grating with n reflecting strips, the principal maximum illumination in the first spectrum occurs in the direction A, which makes, with the normal to the grating, an angle θ, such that $\sin\theta = \lambda/\sigma$, where λ is the wave-length of the monochromatic light, and σ the spacing of the reflecting strips of the grating. In the direction $\theta + \delta\theta$, where $\delta\theta = k\frac{\tan\theta}{2n}$, the illumination is 0 if k is an even integer, and a maximum if k is an odd integer: and the intensities are as stated in the text. Similar results come out when the incident light reaches the grating in other than the perpendicular direction, or when the grating is concave instead of flat.

them surpasses all the others, and has an intensity which we may call I. It is situated in the direction A. The next maxima, one on either side of the principal one, have intensity I′/9, where $I'/I = 4/\pi^2$; the next pair beyond these have intensity I′/25; and so on—the intensities of the lateral maxima decreasing inversely as the squares of the odd numbers. These are consequences of the theory of diffraction gratings. From the above law it follows that the maxima soon become much too faint to be seen by the eye, or to affect a photographic plate, so that what alone can be made visible is the group in the immediate neighbourhood of the position A. This group is what seems to be represented on a very large scale in some of Prof. Michelson's figures, but which in our spectroscopes is so compressed laterally that the whole group appears like one line.

A similar group is necessarily substituted for each physically single line wherever there is one of those limitations of aperture which must occur within the interferometer itself, and, in fact, in every optical instrument. In the astronomical telescope it occasions the spurious disc of a star with its attendant rings. The only question is whether the intervals between the maxima of the group are sufficiently wide to be detected by the interferometer; and as this is simply a question of aperture, or, in the case of a grating, of the number of rulings, it follows that these instrumental groups may be distinguished from physically real groups by the circumstance that the maxima present in them will become more widely spaced if the aperture (or number of rulings) is reduced.

II. *An apparently double line.*—Where the apparatus employed limits the aperture at only one place, the group, which will be substituted for a physically single line, is that described above; at least, if the instrument is in adjustment. But if the arrangements are such as to introduce an actual or virtual limitation of apertures at two places, a double line may result, accompanied by faint appendage lines. What then occurs was discussed in a communication made by the writer to the British Association in 1894 (see Report of the Oxford meeting, p. 583; when also were exhibited examples of such spurious double lines coarse enough to be seen without an interferometer, and where the appendage lines predicted by theory were also seen when the light was intense.

The foregoing instrumental effects arise when the apparatus is accurately collimated. If it be much out of adjustment the groups, substituted for a really single line, are more complicated. But whatever they may be, it is certain that if the resolving power of the interferometer can go sufficiently far, it will bring them into view if they are sufficiently bright to be seen, and that we must then be on our guard against mistaking a resolution of this kind for evidence that the line under examination is physically multiple. G. JOHNSTONE STONEY.

8 Upper Hornsey Rise, N., January 13.

THE remarks put forward by Dr. Stoney are the well-known results of the wave theory, and Prof. Michelson, no doubt, is quite familiar with all that has been said in this department. In addition, he alone is quite familiar with what it is that is actually observed in his interferometer, and therefore must be in a position to give a strong opinion as to whether the observed effects are spurious and due to diffraction or not.

It was with this feeling that I wrote my remarks (p. 228), and I wished to draw some further information from Prof. Michelson on this important subject, rather than in any way to cast doubt on the correctness of his conclusions. I have never worked with the interferometer, and therefore cannot pronounce upon its performance as an optical instrument, but I trust Dr. Stoney's interesting and important observations may have the effect of drawing a full explanation of all the outstanding difficulties.

Bardowie, Orwell Park, Dublin. THOMAS PRESTON.

A Note on Catching Insects, and the Behaviour of the Bulldog-Ant of South Australia.

DURING my visit to South Australia, I wished to obtain some specimens of the insects of the country, for my naturalist friends at home. At first I experienced considerable difficulty in catching those whose movements were rapid, without injuring their bodies. Recently I have been able to secure nearly every specimen seen, by the following method.

A small antitoxin syringe was charged with benzol, and a small jet of the liquid was directed towards the beast sought for (a large tarantula, for example); the result of this form of attack was to render the beast almost instantly inert, so that it was easily secured. I am not at all sure that benzol is the best liquid for the purpose; but I used it, as it happened to be the only substance I could obtain, at a distance from a township, which appeared likely to produce the desired effect. I find that insects which could be easily captured a month ago when it was fairly cool, have become wonderfully active now that the sunshine temperature is about 150° to 155° F.

I placed a large bulldog-ant, about one inch in length, in a glass bottle three and a half inches in diameter; I noticed that when the bottle was on its side, and the ant was clinging to the upper surface of the bottle, with its back pointing downwards, that if the ant was detached by a slight jerk, it fell on its feet. I repeated this experiment many times, with seven different bulldog-ants; in every case the ant fell feet downwards, after the well-known manner of a cat.

As I am no naturalist, I may be describing an acrobatic movement of the bulldog-ant already well known to students of natural history. But even should this be so, probably the fact I have mentioned may be of interest to others.

FREDK. J. JERVIS-SMITH.

Quanbi, Mt. Barker, South Australia, December 16, 1898.

A New Dome for Equatorials.

WITH reference to the note in NATURE of January 12 (p. 257), on "A New Dome for Equatorials," allow me to point out that a rotary dome without a shutter was, as far as I know, first constructed for the observatory in Strassburg. The late Prof. Winnecke, at the meeting of astronomers in Berlin on September 5, 1879, referred to it as follows (*Vierteljahrsschrift der Astronomischen Gesellschaft*, 14 *Jahrgang*, p. 334): "In consequence of the construction of the altazimuth, in which the telescope was placed at the end of the axis, the dome of the north tower had to have an unusually large aperture. This was easily accomplished by employing two separate halves of a hemisphere, which could be rolled back on wheels situated above the circular rail, by which means a complete aperture of 2½ metres could be obtained. The mechanism for the movable parts works easily and surely."

The same construction is described in the *Annalen der Kais. Univ. Sternwarte in Strassburg*, vol. i. p. 7; an illustration of this will be found on Plate vii. (the dome to the left): although both domes—that to the right holding a small refractor, viz. a comet-seeker—are represented as closed, the difference can be seen at once.

I trust that this short historical remark may be mentioned in the next number of NATURE. E. BECKER.

Kais. Univ. Sternwarte, Strassburg, i. E., January 15.

Luminosity of Sugar.

THE communication of Mr. J. Burke to the British Association, on the luminosity of sugar (NATURE, vol. lviii. p. 533) recalls to my mind an illustration on the large scale of the same interesting phenomenon.

In the process of making what is known as granulated sugar, ordinary refined sugar is passed through a revolving sheet-iron cylinder, where it meets with a current of hot air, and is warmed and dried at the same time. On leaving the drying cylinder the sugar is taken by a travelling band, or other carrier, and dropped into a hopper, from whence it is drawn for packing. The sugar falling into the hopper soon forms a pyramidal heap, and when this is examined in darkness, the top of the heap, where the stream of sugar lands, is seen to glow with a steady light blue luminosity.

On rubbing two pieces of ordinary lump or tablet sugar together, in darkness, the glow is readily produced, and when a piece is broken in two there is a bright flash at the moment of fracture. The light produced in this manner is not affected by moistening the lumps with alcohol, but is intensified when water is used.

When hard lumps of sugar are crushed by striking with any solid body, such as a shovel, the glow appears as a flash, and is easily seen even in the presence of dull light, but is, of course, best viewed in complete darkness. Even a heap of loose sugar responds to a blow from a shovel.

Sometimes sugar, as purchased retail, when left in the bag during dry weather, sets to a hard mass. On scraping such with

a spoon or such-like article the light is readily produced, and when two such masses are rubbed together a very strong glow is the result. THOS. STEEL.

Colonial Sugar Ref. Co., Ltd., Sydney, N.S.W.

The Wanton Destruction of Rare Visitants to our Shores.

IN the *Zoologist* for this month (No. 691) is recorded the destruction and capture of the following rare bird visitants to our shores:—Six crossbills, one goshawk, one flamingo, one little bustard, one great shearwater, one avocet, and two Sclavonian grebes. Is it not time this senseless and unwarrantable destruction of these beautiful creatures ceased? Will you, as the leading scientific journal, lift up your voice against it, and earn the gratitude of every lover of nature?

Rottingdean, Sussex. E. L. J. RIDSDALE.

EXPERIMENTS ON THE AUTUMN COLOURING OF PLANTS.

THOUGH in the course of the present century a good deal has been written as to the causes of the autumn tints of leaves, our knowledge of this subject is still in a very unsatisfactory condition. The following notes may serve to show the nature of some of the principal factors involved.

While engaged on some osmotic experiments in the summer of 1897, I made the observation that the newly-formed leaves of specimens of *Hydrocharis morsus-ranae*, which had been placed some days previously in a weak solution of cane-sugar, assumed a rich reddish-brown colour, although otherwise perfectly normal. Further experiments showed that the culture of this plant in solutions of cane-sugar, grape-sugar and fructose constantly has this effect on the colouring of those leaves which are developed during the sojourn of the specimens in these solutions, and that even the leaves which were fully developed before the commencement of the experiments gradually become of the same reddish-brown hue.

This colour is due to the appearance of red cell-sap in the palisade-cells, and in the cells lining the air-chambers of the leaf. A certain number of these cells often contain red cell-sap under normal conditions, especially if the plants are strongly insolated, and the temperature of the water in which they are living is somewhat low; but under these conditions, the leaves never assume a colour approaching to that of plants cultivated in sugar solutions. If the sugar solutions are changed often enough, the plants remain perfectly healthy for weeks, and multiply rapidly by means of suckers. In one set of experiments I have followed the development during four successive generations.

In specimens of Hydrocharis grown in a good light the leaf-stalks, suckers and roots are usually more or less dotted with red under normal conditions; but the number of cells containing red cell-sap is very much increased in these parts of the plant, if the specimens are cultivated in a sugar solution, even though the conditions of light and temperature are much less favourable for the production of the red pigment than in the specimens grown in pure water.

Salt solutions and the solutions of organic compounds other than the carbohydrates have no such effect on Hydrocharis, and even among the sugars galactose is entirely without effect. Lactose acts only after a long period, and the effect is even then very slight and is probably due to hydrolysis.

A few experiments with *Lemna minor* and with *Potamogeton perfoliatus* in solutions of various sugars not leading to similar results, I should probably have laid the whole subject aside, had not my attention shortly afterwards been drawn to the red-colouring of plants in general by a tour in the Upper Engadine just at a time when the autumnal colouring of the Alpine plants was reaching its climax.

There, among the magnificent tints that overspread the mountain slopes, my mind naturally reverted to my laboratory experiments and the possibility of a correlation between the two sets of phenomena suggested itself. Observations and experiments, made upon the spot, led me to the conclusion that there were good grounds for the conjecture that an increase of sugar at the cost of starch might be *one* of the factors concerned in the formation of the red pigment of those leaves which become red in autumn.

Of such leaves there are two distinct classes. The one set comprises the perennial leaves, and those leaves which, formed during the later part of the summer, remain alive till the following spring or summer. This set of leaves (with the exception of those which die in spring) lose their reddish hues with the return of warmer weather (*e.g.* holly, ivy). The other set comprises those leaves which fall and die soon after attaining their reddish tints.

Lidforss[1] has drawn attention to the fact that during the winter the leaves of our native plants are entirely devoid of starch, but contain large quantities of sugar. Without a previous knowledge of Lidforss' paper, I obtained the same results and found that the deciduous leaves at the time they assume their autumn tints contain more sugar and less starch than in midsummer.

The remarkable coincidence of the appearance of red cell-sap with the increase of sugar in autumn and its disappearance in spring at a time when the greater part of the sugar in the leaf is recondensed to starch, together with my observations on Hydrocharis, formed the starting point for a considerable number of experiments on the formation of the red pigment of leaves.

These experiments and observations have led me to conclusions which may be stated broadly thus:—

The red colouring matters of green plants are probably of the nature of glucosides, and are in most cases unions of tannin compounds with sugar.

The chief physical factors in their production are: (*a*) sunshine, which on the one hand augments assimilation and the production of sugar, and on the other hand accelerates the chemical process leading to the formation of the pigment; and (*b*) a low temperature, which prevents the conversion of the sugar into starch. In other words, the red autumnal tints are in great measure the direct result of the autumnal climatic conditions.

It is possible in many plants to produce (red) autumnal tints at any time of the year, by feeding them with glucose.

Generally speaking, this artificial production of red cell-sap is possible only where the natural reddening of the leaf has its seat in the mesophyll cells. In cases where the coloration is in the epidermis, experiments with glucose are unsuccessful.

Among plants especially favourable for experiments on the artificial production of red cell-sap, I may mention various species of *Lilium* (*L. Martagon*, *L. candidum*, *L. umbelliferum*), Holly (*Ilex aquifolium*), various succulent plants, such as *Saxifraga crassifolium*, and among water-plants, besides *Hydrocharis*, the different indigenous species of *Utricularia*.

A full account of these experiments, together with their connection with various phenomena of plant-life, will appear shortly in the *Jahrbücher für wissenschaftliche Botanik*. E. OVERTON.

THE GREAT CATALOGUE OF BIRDS.

THE recent issue of the twenty-sixth volume of the "Catalogue of Birds in the British Museum"[2] (the twenty-seventh and concluding volume having been published in advance in 1895) brings to an end a

[1] *Botan. Centralblatt*, Bd. 68 p. 33 44 (1896).

[2] "Catalogue of the Plataleæ, Herodiones, Steganopodes, Pygopodes, Alcæ, and Impennes in the Collection of the British Museum. By R. Bowdler Sharpe and W. R. Ogilvie-Grant. (London, 1898.)

formidable task, commenced in 1874, which has occupied the time and energies of some of the leading ornithologists of the present day during the past twenty-five years. For it must be recollected that this work, although modestly entitled a "Catalogue of the Birds in the British Museum," is far more than a mere list of specimens. It gives, in fact, besides a list of the specimens in the British Museum, an account of all the known species of birds, embracing their synonyms (*i.e.* the various names which have been applied to them by different authors), descriptions of their various plumages, their countries and all other necessary information concerning them. Such a work, although it has been attempted on several occasions, has never been brought to a conclusion since Latham completed his "General History of Birds" in 1824. And in Latham's days, it should be remembered, a general history of birds was a comparatively easy matter. Latham was acquainted with only some 4300 species of birds, which he grouped in 112 genera. The British Museum Catalogue gives us an account of 11,617 species of birds, arranged in 2255 genera, showing that our knowledge of the class Aves has increased nearly three-fold since 1824.

The "Catalogue of Birds" was commenced in 1874, and finished in 1898. As completed, it forms twenty-seven octavo volumes, varying in extent from 300 to 800 pages each, and illustrated by numerous coloured plates. We give a list of the authors, contents, and dates of issue.

Vol.	Contents.	Author.	Date.	No. of Genera.	No. of Species.
I.	Accipitres	R. B. Sharpe	1874	80	389
II.	Striges...	R. B. Sharpe	1875	19	190
III.	Coliomorphæ	R. B. Sharpe	1877	94	370
IV.	Cichlomorphæ, Pt. I..	R. B. Sharpe	1879	81	520
V.	Cichlomorphæ, Pt. II.	H. Seebohm	1881	18	344
VI.	Cichlomorphæ, Pt. III.	R. B. Sharpe	1881	66	407
VII.	Cichlomorphæ, Pt. IV.	R. B. Sharpe	1883	164	687
VIII.	Cichlomorphæ, Pt. V., and Certhiomorphæ	Hans Gadow	1883	46	402
IX.	Cinnyrimorphæ ...	Hans Gadow	1884	35	355
X.	Fringilliformes, Pt. I .	R. B. Sharpe	1885	63	448
XI.	Fringilliformes, Pt. II.	P. L. Sclater	1886	100	575
XII.	Fringilliformes, Pt. III.	R. B. Sharpe	1888	101	559
XIII.	Sturniformes	R. B. Sharpe	1890	129	601
XIV.	Oligomyodæ	P. L. Sclater	1888	142	665
XV.	Tracheophonæ ...	P. L. Sclater	1890	92	531
XVI.	Upupæ and Trochili.. Coraciæ	O. Salvin ... E. Hartert...	1892	163	687
XVII.	Coraciæ (*continued*) and Halcyones ... Bucerotes and Trogones	R. B. Sharpe W. R. Ogilvie Grant ...	1892	67	397
XVIII.	Scansores	E. Hargitt...	1890	50	385
XIX.	Scansores and Coccyges...	P. L. Sclater and G. E. Shelley ...	1891	87	448
XX.	Psittaci	T. Salvadori	1891	79	499
XXI.	Columbæ	T. Salvadori	1893	68	415
XXII.	Pterocletes, Gallinæ, Opisthocomi, Hemipodii	W. R. Ogilvie Grant	1893	94	426
XXIII.	Fulicariæ and Alectorides	R. B. Sharpe	1894	88	252
XXIV.	Limicolæ	R. B. Sharpe	1896	102	255
XXV.	Gaviæ ... ... Tubinares	H. Saunders O. Salvin ...	1896	46	224
XXVI.	Plataleæ, Herodiones, Steganopodes, Pygopodes, Alcæ, and Impennes	R. B. Sharpe and W. R. Ogilvie Grant ...	1898	98	290
XXVII.	Chenomorphæ, Crypturi, and Ratitæ ...	T. Salvadori	1895	83	296
				2255	11,617

The Catalogue was commenced in 1872 by Dr. R. Bowdler Sharpe, soon after he had succeeded the late George Robert Gray in the charge of the national collection of birds. To the late Dr. John Edward Gray, then Keeper of the Zoological Department, must be ascribed the credit of starting it, though he only lived to see the first volume brought to completion. This was issued in 1874, and contained an account of the diurnal birds of prey; it was followed in 1875 by the second volume, also prepared by Dr. Sharpe, devoted to the owls. After this Dr. Sharpe proceeded to attack the long array of Passeres, an order which embraces rather more than half the whole number of known birds, and got out two volumes on the subject in 1877 and 1879. The late Henry Seebohm—a distinguished traveller and ornithologist—one of whose pet groups was the thrushes and their allies, was then invited by Dr. Günther, who had succeeded Dr. Gray in the keepership of the zoological department, to prepare the catalogue of this family. Seebohm produced it in 1881, after what, he tells us, was "two close years of application" to a very difficult task. Meanwhile Dr. Sharpe was working away at other groups of the great Passerinie Order, and succeeded in issuing two more volumes (vols. vi. and vii.) in 1881 and 1883. By this time, however, Dr. Günther had quite satisfied himself that if the Catalogue of Birds was to be finished within a reasonable period it would be necessary to obtain further aid from outside. The task was far too vast for the unassisted efforts of a single ornithologist, who had, moreover, the charge and arrangement of the enormous national collection of birds on his shoulders, however hard he might work. Failing to find any qualified British ornithologist with leisure to help him, Dr. Günther naturally turned to Germany, and invited the aid of Dr. Hans Gadow (now settled at Cambridge), to whom we are indebted for the compilation of vols. viii. and ix. of the "Bird-Catalogue." Dr. Günther also managed to persuade Mr. Sclater, the Secretary of the Zoological Society, who was the possessor of a very full series of American birds, not only to part with them in favour of the national collection, but also to undertake to prepare the catalogues of some of the groups that he had made the special subjects of his studies. It thus came to pass that three volumes of the catalogue of Passeres, and half of a fourth volume relating to the Scansores, were written by Mr. Sclater. The very difficult and laborious task of cataloguing the humming birds (Trochilidæ), with some 500 species, was in the meanwhile entrusted to the late Mr. Osbert Salvin, and, we need hardly say, was most efficiently performed by that accomplished and accurate naturalist. Mr. Hartert (of the Tring Museum) joined forces with Mr. Salvin, and contributed an account of the swifts and goat-suckers to the same volume, which forms the sixteenth of the series. Another expert—the late Mr. Hargitt, was employed on the catalogue of woodpeckers (vol. xviii.)—a group to which he had paid special attention, while Captain Shelley undertook the cuckoos, Count Salvadori the parrots and pigeons, and Mr. Ogilvie-Grant the game-birds—groups with which, in each case, the authors were already respectively familiar. In this way, at the end of 1893, twenty-two volumes of the Catalogue had been brought to a conclusion, and only five more remained to be accomplished. Some little difficulty, we believe, was experienced by Dr. Günther in allocating these five volumes in a satisfactory manner, but Mr. Howard Saunders, our chief authority on the Laridæ (gulls and terns), was obviously the [proper person to undertake their enrolment in the national catalogue, and at the same time his most valuable private collection of these birds was secured for the Museum. Nor was it less obvious that the late Osbert Salvin was the person to whom the charge of the petrels, a very difficult group, of which he had long made a special study, should be assigned. Both these selections were most satisfactory, and the result was that vol. xxv., produced by the joint efforts of these two ornithologists in 1896, is one of the best of the long series. At the same time the veteran systematist, Count Salvadori, of Turin, undertook the final volume (xxvii.), containing the Anseres (ducks and geese), the tinamous and the ostriches;

and the three remaining volumes (xxiii., xxiv. and xxvi.) were assigned to the hard-worked officials of the British Museum. Of these Dr. Sharpe got out one in 1894, and another in 1896. The twenty-sixth volume, of which the first half was prepared by Dr. Sharpe, and the second by Mr. Grant, has now just made its appearance, and renders the long series of twenty-seven volumes complete.

Taking this laborious piece of systematic work as a whole, there can be no question, we think, of its value. This has been indeed acknowledged by naturalists all over the world, whose anxious inquiries for many years have been as to the prospects of its being brought to a conclusion. The variation in treatment of the different portions of the work, caused by the idiosyncracies of the eleven ornithologists who contributed to its composition, was of course unavoidable. No one person could have accomplished the task, and a wise discretion on minor points was left to those who helped in its composition. Some of them have made many generic divisions, others few. Some have written long descriptions, others short ones. Some have employed one set of rules of nomenclature, others have followed another code. Greater uniformity on all these points would, of course, have been very desirable. But it was practically unattainable, and its absence has scarcely diminished the usefulness of the whole series. During its progress, however, great additions have been made to our knowledge of many of the groups, especially to those treated of in the earlier volumes. From Sir William Flower's preface to the twenty-sixth volume we are pleased to learn that a supplement, containing references to every species of bird described subsequently to the publication of the volume which treats of the group to which it belongs, is in preparation, and will be accompanied by a general index. This will be a most valuable addition, and will serve to render the vast stores of ornithological lore comprised in the twenty-seven volumes of the "Great Catalogue of Birds" still more useful to future workers. Those who have planned and those who have carried out this important undertaking alike deserve the grateful thanks of all zoologists.

SIGNS OF PROGRESS IN SCIENCE TEACHING.

DURING the past Christmas vacation, London, Manchester, Shrewsbury and other places have been astir with educational conferences. These have been attended by teachers of all ranks. The College of Preceptors held a gathering which lasted a fortnight, with daily morning and afternoon sessions, including a conference of science teachers organised by the Technical Education Board of the London County Council. These conferences have dealt not only with questions of organisation, but largely with the subjects to be taught, and the methods of teaching them. The increasing interest in the movement is also indicated by the appearance of new educational journals, in addition to those that already occupy the field. One of these, *The School World*, has special reference to modes of instruction, together with articles on different departments of the subject by good writers of the advancing school. Progress is also shown by the much more general introduction of the teaching of science. The public elementary schools have mostly introduced science into their scheme of instruction, and it occupies a more and more worthy place in their time tables. All the great public schools include some amount of science in their curriculum. The universities of course have professorships of various sciences, and these are better attended by students than formerly. The intermediate schools, which are under private management, are following suit, though in very various degrees.

But what is the teaching of science? The time is past for the chemistry lesson to consist merely of the precipitation of the highly coloured chromates or iodides, and the explosion of oxygen and hydrogen; or to appear as "la chimie amusante" in the prospectus of a young ladies' school. It is perhaps generally recognised that physics and chemistry cannot be taught merely from text-books; that would be uninteresting, and scarcely instructive. Nor must the teaching depend solely upon showy demonstrations on the lecturer's table. These may be attractive, but they often leave only a confusion of ideas in the mind of the student. There is a great tendency now to recognise that the pupils should not only read descriptions of objects, but see and handle them; not only watch experiments, but perform them. There is a movement in many quarters to adopt the "Heuristic" method, so strongly advocated by Prof. Armstrong, by which the student is led to find out results or causes for himself, and to express them intelligently in writing. This is a truly educational method: but it has its limitations. One of these is the amount of time that can be given, as from the very nature of it this must be a slow process: another is that the teacher ought himself to suggest certain lines of research, and watch over the student's progress, directing him unconsciously towards the right conclusions.

In this transition period there are two practical difficulties. First, the want of teachers sufficiently imbued with the new methods to carry them out successfully. Secondly, the examination which usually forms a necessary part of the student's career. This examination is generally founded more upon the old than the new methods, and is directed to ascertaining the amount of the student's knowledge rather than the discipline which his mind has received. It is important to bear in mind what is the chief object in view; not so much to teach a specific science as to indoctrinate the student in the principles which underlie all science, and which will be of essential service to him in whatever calling he may afterwards engage: not so much to store his mind with facts, as to develop his faculties—his powers of observation and reasoning. In bringing about such a reform the practical teacher may often find it necessary to proceed, not by a sudden revolution, but by gradual modifications and improvements in method.

J. H. GLADSTONE.

PROFESSOR ALLEYNE NICHOLSON.

TO all students of zoology (in its most extended sense) the name of Alleyne Nicholson is so familiar, that the recent announcement of his premature death will probably have caused a sense of personal loss even to those who never enjoyed the pleasure of his acquaintance. By those who did know him personally, the general charm of his manner, and his enthusiasm for his favourite science, will not readily be forgotten.

Henry Alleyne Nicholson was born at Penrith, Cumberland, in the autumn of 1844; his father being Dr. John Nicholson, who gained considerable distinction as a linguist and philologist, especially in Oriental literature. The son was educated first at Appleby Grammar School, subsequently at Göttingen, and finally at the University of Edinburgh. At the latter University he gained the Baxter Natural Science Scholarship; and when only twenty-five he was appointed (in 1869) Lecturer on Natural History in the Extra-Mural School of Medicine in that city, an appointment which he held till 1871, when he became Professor of Natural History and Botany in the University of Toronto. He did not, however, remain long at the latter post, moving to Durham in the same capacity in 1874; while one year later (1875), he accepted the

Natural History Professorship at St. Andrews. This post he held till 1882, when he was appointed Regius Professor of Natural History in the University of Aberdeen; and here he died in harness, respected and esteemed alike by colleagues and pupils. The degrees of M.D. (Edinburgh) and D.Sc. he took in due course; and he was also Ph.D. of Göttingen. In 1888 he was the recipient of the Lyell medal from the Geological Society. He also held the Swiney Lectureship in Geology from 1877 to 1882, and a second time from 1890 to 1894, when it had come under the direction of the Trustees of the British Museum. He was elected a Fellow of the Royal Society in 1897.

Although his life's work covered a very wide field, perhaps Nicholson's best claims to distinction will rest on his researches into the structure and affinities of the Stromatoporoids and the Graptolites. But, although all his conclusions did not meet with general acceptation, it would be unfair not to mention also his works on the Monticuliporoids and the Palæozoic Tabulate Corals. And here it should be observed that, through no fault of his own, his investigations of these latter groups took place a little too early; so that when the results of the *Challenger* discoveries became known, several modifications of view were rendered necessary. The older rocks of the Lake District likewise claimed a large share of his attention; many of his summer vacations being diverted, with a genial companion, to the elucidation of the difficult problems they present. His claims to distinction as a palæontological student of the lower Invertebrates are recognised by the dedication to him of the recently described *Millestroma Nicholsoni.* The important part he played in determining the rock-succession in the Lake District must not be forgotten in estimating his achievements. Nicholson's most widely-known monument will, however, undoubtedly be the large series of zoological and palæontological text-books, which have rendered his name a household word in every science-school and university where the English tongue is spoken. These had but comparatively humble beginnings; and it is to the credit of their author that, as they acquired a wider and wider reputation, he rose to the occasion by endeavouring to bring the later editions to a higher level than that on which he had started. Whether the plan of separating palæontology from zoology proper is the best that could have been devised, or the one likely to be followed in the future, this is neither the place nor the occasion to enquire. But, from a student's standpoint, it may be admitted that the first volume of the last edition of his "Palæontology" is almost the ideal of what a text-book should be. Personally, we knew him as a teacher only by a too brief portion of his last series of Swiney lectures; but, apart from the testimony of those who have enjoyed more favourable opportunities, his books are sufficient to proclaim how admirably suited he was for the important position he occupied with so much distinction.

The University of Aberdeen will have no easy task to secure a worthy successor! R. L.

NOTES.

A FULL biography of the Polish philosopher Hoené-Wronski has been in preparation during the past seven years. Wronski resided in London in 1820–22, and Mr. Zenon Przesmycki, who has the work in hand, would be very grateful for any further information, or access to correspondence, bearing on Wronski's life during that period. Mr. Przesmycki was in London last summer, and through the kindness of the authorities of Greenwich Observatory, the Admiralty, Royal Society, British Museum, and Record Office, he was able to consult various important documents. But no trace was found of a paper ("Réforme de la théorie mathématique de la terre") of his, presented to the Royal Society in June 1820, by the hands of the Astronomer Royal, Mr. Pond, nor of two printed extracts of this paper which Mr. Pond was authorised by the Society to make: their titles being (1) "Extrait du mémoire de M. Hoené-Wronski sur la théorie de la terre"; (2) "Nouveaux extraits du mémoire de M. Hoené-Wronski et de son appendice, principalement sur la théorie des fluides, 1821." The publication now of these facts, and that when in London Wronski corresponded frequently with Pond, with the mathematician Davies Gilbert, with the Rev. Mr. Nolan, and with Lord Melville, then First Lord of the Admiralty, and that he resided in Thiot's Hotel, at 15 Bucklersbury Square, may help to the discovery of further particulars. Dr. Alexander Galt, of Glasgow University, will be glad to receive, for Mr. Przesmycki, any information upon these matters.

AT its annual meeting, on January 10, the Russian Academy of Sciences awarded its Helmersen premium to A. Mickwitz for his work, "Die Brachiopoden. Gattung *Obolus*, Eichwald"; the Lomonosoff premium to N. I. Andrusoff for his work, "The fossil and the living *Dreissenidae* of Eurasia"; to E. Burinsky, for his improvements in photography; and to P. I. Brounow, for his works in meteorology. The large Tolstoi medal was awarded to L. Besser and K. Ballod, for their researches into the natality and mortality of the populations of European Russia, the Baltic provinces, and different countries of Europe, including Great Britain; and the small medal to P. G. Matsokin, for a MS. work on the half-breeds of Transbaikalia.

PROF. RAY LANKESTER makes the welcome announcement that arrangements have been made for the supply of electric lighting to the Natural History Museum, South Kensington. The electric light will be gradually introduced into the various parts of the building—first of all into the offices and studies of the staff and the workshops in the basement, and then into the various public galleries.

HERR J. BORNMÜLLER starts this month on a botanical expedition to the less-known mountains of Northern Persia.

DR. DON FRANCISCO P. MORENO, director of the La Plata Museum, and commissioner of the Argentine Republic in the boundary delimitation with Chile, has arrived in London from Buenos Ayres.

WE regret to read, in the *Athenaeum*, that, in a fire which broke out in the physical laboratory of the University of Geneva, Prof. Chodat has lost the whole of his valuable herbarium, together with two hundred botanical drawings, the result of ten years' labour. A large number of botanical specimens, lent by other institutions, have also been destroyed.

A SERIES of lectures will be delivered in the Lecture Theatre of the South Kensington Museum on the following Saturdays, at 3.30 p.m.:—January 28 and February 4, Dr. W. J. S. Lockyer, "Astronomical Instruments"; February 11 and 18, Mr. J. H. Pollen, "Furniture"; February 25 and March 4, Mr. William Burton, "Pottery."

THE Nicaragua Canal Bill has passed the U.S. Senate. The Bill provides for the construction of the canal by the present Nicaragua Maritime Canal Company. The United States will control the canal, and own all the stock except $7\frac{1}{2}$ per cent. given to Nicaragua and Costa Rica. Each of these will have one director, the United States appointing five. The neutrality of the canal is guaranteed by the United States. The canal is to be used by all nations at equal tolls. It is to be completed within six years. Its cost is limited to 115,000,000 dollars, and not more than 20,000,000 dollars are to be expended annually.

Science announces the death, at Philadelphia, of Dr. E. Otis Kendall in his eighty-first year. Dr. Kendall was for more than fifty years professor of mathematics in the University of Pennsylvania, though recently he had relinquished active duties. He had also held the chair of Astronomy in the University, and was for a long time dean of the scientific department, and was in 1883 elected vice-provost, being honorary vice-provost at the time of his death. Dr. Kendall was for twenty-eight years one of the secretaries of the American Philosophical Society, and for the following twenty-one years one of its vice-presidents. He was the author of a text-book of astronomy and of various contributions to mathematics, as well as of computations for the U.S. Nautical Almanac and the U.S. Coast and Geodetic Survey.

THE death is announced of Dr. Joseph Coats, professor of pathology in the University of Glasgow. Dr. Coats was born in 1846, and he received his preliminary education at Paisley and his medical education at the Universities of Glasgow, Leipzig, and Würzburg. He was appointed editor of the *Glasgow Medical Journal* in 1878, and was degree examiner in pathology 1879-82, lecturer on pathology 1890-94, and professor of pathology since 1894 at the University of Glasgow. He was president of the Pathological Society in 1876, and president of the Medico-Chirurgical Society in 1891. He was the author of several medical works, and he also contributed numerous papers to the various learned societies and medical journals.

THE Paris correspondent of the *Lancet* reports that Dr. Dumontpallier has died at the age of seventy-four years. He was a member of the Academy of Medicine, president of the Society of Biology, an Officer of the Legion of Honour, and was for many years physician to the Hôtel Dieu. Of recent years he has been best known by his researches into hypnotism and hypno-therapeutics, in which he had a great belief.—The death is also announced of Dr. Camille Dareste, professor at the Paris School of Anthropology. He was best known for his researches in embryology, and was practically the founder of the science of experimental teratology, while his researches on the artificial production of monsters created very widespread interest. He was formerly the professor of medicine at Lille, and some fifteen years ago went to Paris as director of the school for higher education.

A SERIES of severe earthquake shocks occurred in some parts of Greece on Sunday morning. The *Times* correspondent at Athens reports that nearly the whole Peloponnese was visited by the disturbance. Severe shocks were felt at Corinth, Megara, Tripolis, Sparta, Gythium, Patras, and Pyrgos, but little damage was done at these places. Messenia, however, experienced the full force of the earthquake, and, besides considerable destruction of property in the towns of Philiatra and Kyparissia, two or three neighbouring villages are reported to be in ruins or uninhabitable. Prof. Milne states that the earthquake reached the Isle of Wight at 8h. 24m. 55s. on Sunday morning. There were preliminary tremors for three minutes, and then three shocks, followed by the usual echoes or reverberations, three in number.

THE Swiney Prize for the present year has been awarded to Dr. J. Dixon Mann, Professor of Forensic Medicine and Toxicology at Owens College, Manchester, for his book on "Forensic Medicine and Toxicology." The prize, in accordance with the will of the testator, is awarded on every fifth anniversary of his death to the author of the best published work on jurisprudence. It consists of a silver goblet of the value of 100*l*., with money to the same amount. Dr. Swiney died fifty-five years ago, and the award has been regularly made every fifth year to the present time. The Society of Arts are the trustees of the fund, and the award is made by that Society and the Royal College of Physicians. Having regard to this fact, the prize has up to the present date been given alternately for works on general jurisprudence and on medical jurisprudence.

A MEETING of the Institution of Mechanical Engineers will be held on Thursday and Friday, February 9 and 10, at the new house of the Institution, Storey's Gate, St. James' Park. The chair will be taken by the president at half-past seven p.m. on each evening. The annual report of the council will be presented to the meeting on Thursday, and the annual election of the president, vice-presidents, and members of council will take place on the same day. The retiring president, Mr. Samuel W. Johnson, will induct into the chair the president-elect, Sir William H. White, K.C.B., F.R.S. The following papers will be read and discussed, as far as time permits:—Fifth Report to the Alloys Research Committee: Steel, by Prof. Roberts-Austen, K.C.B., F.R.S.; Machinery for book and general printing, by Mr. William Powrie; Evaporative Condensers, by Mr. Harry G. V. Oldham.

THE following particulars, referring to the experiments made by the Wireless Telegraph Company between the South Foreland lighthouse and the East Goodwin lightship, are given in the *Electrician*:—Permission was granted by the Trinity House authorities for the Company to make use of either the East-Goodwin, the Gull-stream, or the South Sand-Head light-vessel—the land station to be at the South Foreland lighthouse—and they chose the furthest off of these light-vessels, namely, the East Goodwin lightship, which is twelve miles distant from the South Foreland lighthouse. All the apparatus was brought on the lightship in an open boat and rigged up in the course of an afternoon, and on Christmas Eve the lightship and lighthouse were placed in perfect telegraphic communication. Many messages passed on that day, and there has not been the slightest hitch from the starting of the installation to now, every message sent from either shore or ship being perfectly received at the corresponding station. Although the weather has been most tempestuous since the instruments were installed, they have not been in the slightest degree affected.

TWO papers upon the subject of steel rails were read at the meeting of the Institution of Civil Engineers on January 17. Mr. W. G. Kirkaldy recounted how experiments he had carried out on two steel rails, which had broken under traffic, had led to his devoting special attention to the subject and to a wider investigation. It was found that the breakage of rails resulted from failure commencing at the top surface, and not from the bottom, as appeared to be the usual belief, and that the deterioration was confined entirely to the top or running head. The deterioration was of the nature of a mechanical hardening of the surface under the action of the rolling load. In some cases this hardening further developed into a species of disintegration by the formation of minute transverse cracks, which, by gradual deepening, ultimately resulted in failure, unless the rail was removed in time.

PROF. W. C. ROBERTS-AUSTEN, K.C.B., F.R.S., at the meeting referred to above, gave a statement of the principles which guide microphotography of steel rails. The most generally useful information as to the structure of a steel rail is obtained by treating a highly polished surface of the section with an effusion of liquorice in water, which stains the pearlite a dark tint, and leaves the ferrite unacted upon. The most convenient magnification is between 100 and 150 diameters. Normal rails have thus been shown to consist of patches of pearlite set in ferrite; and although the structure is common to all rails, the ratios of the areas differ widely, the amount of carbon increasing with the area of the pearlite. If the ferrite is

arranged in large, enclosed polyhedrons, the temperature to which the rail was raised before rolling was too high. The strength and intensibility increase as the size of the grain diminishes; and closely interlocking ferrite and pearlite represent the condition which most favours the prolongation of the life of the rail.

IN connection with the works now being carried out for the construction of the new Vauxhall Bridge, the contractors have erected a suspension cable way across the Thames, for the purpose of conveying material from the shore to the different parts of the works. The length between the supports, each of which is 80 feet above the ground, is 910 feet; and the main cable, which is made of steel, is $6\frac{1}{2}$ inches in circumference. The cost of this cableway is about 2000*l*.

A CIRCULAR, appealing for additional telegonic work, has been sent to biologists, and others whose interest in the subject is known, by Messrs. Alex. Meek and G. P. Bulman. In the course of the note it is remarked: "After a careful study of the facts already ascertained regarding telegony—that peculiar phenomenon of cross-breeding, popularly termed "throw-back" —we see that these can be attributed to reversion with almost as much likelihood as to telegony." It is, however, believed that telegonic effects are sometimes shown by the offspring; but more experiments are needed, and the circular indicates the kind of information required. Messrs. Meek and Bulman are conducting as many experiments as they can; but telegony is without doubt of extreme rarity, and the more trials that are made, the greater is the chance of success. Those who will assist are invited to send the skins of the parents and young which display telegony; also, in the case of birds, to send an egg out of each batch. All communications should be addressed to Mr. G. P. Bulman, Durham College of Science, Newcastle-upon-Tyne.

MESSRS. MAYER AND MÜLLER, of Berlin, are publishing in three volumes the mathematical correspondence of Gottfried Wilhelm Leibnitz, under the editorship of C. J. Gerhardt.

A CORRESPONDENT, writing in the *Journal of Applied Microscopy*, suggests that a convenient "pointer" for class demonstrations with the microscope may be made by cementing a human hair to the diaphragm of the eye-piece, projecting into the centre of the field. A better plan would be to cement the hair to a circular ring of blackened paper or cardboard, which could be placed on the diaphragm or removed at will.

A NEW bi-monthly journal has been started in Paris, bearing the title *L'Enseignement Mathématique*. It is to be devoted to discussion of methods of teaching mathematics, with the object of forming a medium of intercommunication between professors and others engaged in this particular branch of teaching. The first number bears the date January 15, 1899. The editors are Dr. C. A. Laisant (Paris) and Prof. H. Fehr (Geneva), and the publishers are MM. Georges Carré and C. Naud, 3 Rue Racine, Paris.

IN the *Nuovo Cimento*, 4, viii., Drs. V. Boccara and A. Gandolfi describe experiments on the velocity of propagation of Hertzian waves, undertaken for the purpose of verifying the well-known relation $v = 1/\sqrt{(k\mu)}$. The media operated on consisted of mixtures, in various proportions, of paraffin and finely pulverised iron. Both the magnetic permeability and the specific inductive capacity could be increased by increasing the proportion of iron, and the index of refraction for electromagnetic waves was found to increase correspondingly, its value (n) being given approximately by the relation $n = 1/\sqrt{(k\mu)}$. This relation may, therefore, be regarded as verified experimentally.

A NEW departure in connection with projection microscopes has been constructed for Prof. M. C. White, of Yale University, in the form of an objective of 20 mm. focal length, and an estimated numerical aperture of 0·95. According to the *Journal of Applied Microscopy*, the new objective is a magnified copy of a 5 mm. apochromatic, the diameters and radii of curvature of all the lenses being increased fourfold. Dr. White's theory is that if, in using the ordinary microscope, a certain angular aperture is required to secure proper definition with a magnifying power of, say, 1000 diameters, then a similar aperture will be necessary to secure good definition in an image projected on the screen, even if it is obtained with a three-fourths-inch objective, and a projection eyepiece. The new lens has been manufactured by the Bausch and Lomb Optical Company.

IN experiments upon the discharge of negative electricity by light, the electric arc is usually employed as the source of ultra-violet rays, and a question arises as to how far such experiments are affected by the electrical state of the vapours of the arc. The *Physical Review*, vol. vii. pp. 129–148, 1898, contains an article on this subject by Messrs. Merritt and Stewart. It was pointed out by Hallwachs, in 1890, that the protection offered by a quartz window and wire gauze is in some cases insufficient to screen the direct electrical action of the arc vapours from the actino-electric apparatus. The electrical properties of the arc vapours are similar to those of gases that have been acted upon by X-rays, or to gases from a flame. It is supposed in these cases that a condition is developed in the gas somewhat similar to that in an electrolyte, *i.e.* ions are formed, some carrying positive charges and others negative charges. This condition is only temporary; in the case of X-rays the gas loses this ionised state in about one-tenth of a second. A charged body placed in the ionised gas would attract one set of ions and repel the other. Upon coming into contact with the charged body the ions are supposed to give up their charges and to cease to exist as ions. The experiments of Messrs. Merritt and Stewart show that, except at low potentials, the rate of discharge is not proportional to the potential, but approaches a limiting value as the potential is raised. The discharging power is retained even after the arc vapours have been passed through long tubes of glass or of metal, and lasts for at least ten seconds. There is some evidence that the negative ions diffuse more rapidly than the positive ones. If air or oxygen saturated with water-vapour is introduced into the enclosure containing the arc, the conducting power of the arc vapours is greatly increased. But this effect can no longer be observed when the body to be discharged is at considerable distance from the arc.

FROM the Geological Survey of Canada we have received several essays reprinted from the Annual Report, vol. ix., 1898. A report on the geology of the French River Sheet, Ontario, by Dr. Robert Bell, is a concise explanation of one of the Geological Survey maps (Sheet 125), printed in clear type, accompanied by a colour-printed map on the scale of an inch to four miles, and issued at the price of ten cents! Laurentian, Huronian, Ordovician, and Silurian rocks are described, as well as Glacial and other superficial deposits. Among "economic minerals" it is observed that certain white quartzites would furnish excellent material for making glass.

MR. A. P. LOW reports on a traverse of the northern part of the Labrador peninsula from Richmond Gulf to Ungava Bay. Proceeding along the eastern shores of Hudson Bay, Mr. Low explored Richmond Gulf, which is separated from Hudson Bay by a high narrow ridge of Cambrian rocks, capped with trap, and forming cliffs which rise 500 to 1200 feet above the water. Between the Gulf and Clearwater Lake there is a plateau, having

a general elevation of 750 feet, formed of rounded granitic hills, with numerous intervening lakes. North of Clearwater Lake is Seal Lake, which derives its name from the seals living in its waters. Mr. Low thinks that the presence of these animals in the lake, which is nearly a hundred miles from salt-water, and at an elevation of nearly 800 feet above the sea, can hardly be due to migration, although the harbour seal is known to travel overland for considerable distances. He considers that the seal must have reached the lake during the subsidence of the land at the close of the Glacial period. It evidently breeds freely under the fresh-water conditions. Explorations were made by Mr. Low as far as Fort Chimo, the most northerly post of the Hudson's Bay Company in Labrador. The rocks met with along the greater part of the route have been classed as Laurentian; they consist chiefly of foliated granite. Other eruptive rocks, also cherty dolomite and shales, grouped as Cambrian, were met with. The observations of striæ and other Glacial phenomena showed that the region had been completely covered with ice during the Glacial period, and that the ice moved outwards and downwards from a narrow névé near the present watershed. Old marine terraces were also noted.

JUDGING from the twelfth annual report of the Liverpool Marine Biology Committee, the biological station at Port Erin, Isle of Man, was used by a number of naturalists last year, and several investigations of interest and importance have been made with material collected from the neighbouring coasts. An interesting illustration in the report is a reproduction of a photograph, taken in June 1897, of a marked area of rock covered with adhering animals. By the side is another picture of the same area photographed after a year's interval, and it shows that the original population had disappeared almost entirely. All the original limpets had gone, leaving their scars on the rock; but a few barnacles seem to have remained. Many thousands of new animals appear on the second picture.

THE second instalment of the "Additional Series" of the *Kew Bulletin* forms the first of a series of "Selected Papers," and is devoted entirely to vegetable fibres. It comprises eighty-nine papers, amounting to 280 pages, already published in the *Bulletin*, and forms a valuable work of reference for all interested in the subject, whether scientifically or commercially.

RETURNING to the subject of the injury inflicted on agriculture in New South Wales by the introduction of the prickly pear, Mr. Maiden, the Government botanist for the Colony, now publishes (*Miscellaneous Publication*, No. 253, Department of Agriculture) a description of the six species of *Opuntia* at present naturalised in the colony, each illustrated by a good full-sized plate.

THE first number of Cohn's *Beiträge zur Biologie der Pflanzen* published under the editorship of Prof. Brefeld, consists of three papers: on the witch-broom of the barberry, by Dr. J. Eriksson; on the development of the Helvellineæ, by Herr G. Dittrich; and on inulin, by Dr. H. Fischer. Dr. Fischer believes inulin to be a substance of much wider distribution in the vegetable kingdom than has generally been supposed. It is never a final, but always an intermediate, product in the process of assimilation. It may be formed by condensation out of fructose, which, after transport to the reserve receptacles, is again transformed into inulin, then into glucose, and finally into starch.

WE have received a reprint of a lecture on the South Wales Coal-field, by Mr. W. Galloway, being Subject I. of a course of lectures on mining, published by the South Wales Institute of Engineers. The lecture is illustrated by a capital colour printed geological map showing the areas occupied by the steam-coal and anthracite collieries. The structure of the coal-field is well explained, and there is a general account of the mode of formation of coal, and of the organic remains of the Carboniferous period.

PROF. ARTHUR THOMSON will contribute a series of papers to *Knowledge*, dealing with the treatment and uses of anthropological data. The first article is to appear in the February number.

IN aid of the funds of the Distressed Gentlefolk's Aid Association, Mr. C. Carus-Wilson will lecture upon "The Marvels of Ice and Glaciers," at the Kensington Town Hall, on Wednesday, February 1, at 8.30 p.m.

"THE Resources of the Sea; or, an Inquiry into the Experiments on Trawling and the Closure of Areas," is the title of a work, by Prof. McIntosh, to be issued shortly by the Cambridge University Press. The work is accompanied by thirty-two tables, and various photographs and figures.

A COPY of an important paper on cell structure and nuclear division, entitled "Über Zellen- und Syncytienbildung. Studien am Salmonidenkeim," by Prof. Wilhelm His, has been received. The paper is an excerpt from the *Abhandlungen der mathematisch-physischen Classe der Konigl Sächsischen Gesellschaft der Wissenschaften* (vol. xxiv. No. 5), and is illustrated by forty-one figures in the text.

TWO volumes (vols. i. and v.) of the "Traité de Zoologie Concrète," by Prof. Yves Delage and M. Hérouard, have already been noticed in these columns (vol. lviii. p. 25, May 1898). Another volume (vol. viii. pp. 379), dealing with the Chordata, and containing 54 plates and 275 figures in the text, has just been published. There will be nine volumes in all, only three of which have yet been published.

UNDER the title "The Last Link; our Present Knowledge of the Descent of Man," the paper read by Prof. Ernst Haeckel at the International Congress of Zoologists last August (see vol. lviii. p. 427), has been published by Messrs. A. and C. Black, with notes and biographical sketches by Dr. Hans Gadow, F.R.S. Prof. Haeckel states his case in eighty pages, and Dr. Gadow's biographical sketches, and instructive notes on the theory of cells, factors of evolution, and geological time occupy seventy-six pages.

THE Wagner Free Institute of Science, Philadelphia, has published the fourth part of Prof. W. H. Dall's memoir on the "Tertiary Fauna of Florida," with special reference to the silex beds of Tampa, and the Pliocene beds of the Caloosahatchie river, and including in many cases a complete revision of the generic groups described, and their American Tertiary species. The present part of the work includes the Prionodesmacea and Teleodesmacea. Prof. Dall expresses the hope that another part will conclude this series of papers, and comprise, besides the remaining descriptions, a summary of the faunal population of each of the principal Neocene horizons.

THE Vatican Observatory has recently issued volume v. of *Pubblicazioni* (xxiii. + 808 pages). The work is divided into four sections—astronomy (including observations of shooting stars), terrestrial magnetism, earthquake phenomena, and meteorology. The meteorological observations for the years 1893 and 1894, and ten-day and monthly means, are tabulated under each hour, in addition to the usual daily means and extremes. The whole work is beautifully executed, and contains some good astronomical and other plates. About 220 pages are devoted to a summary of the proceedings at the weekly meetings held at the observatory during the years 1894 and 1895.

THE annual report of the Smithsonian Institution for the year ending June 1896 has been received. It is well known that the value of Smithsonian Reports lies not so much in the account of the operations and conditions of the Smithsonian Institution as in the collection of papers on various scientific subjects, included in the appendix. The report of the Secretary on the work of the Institution is published many months in advance of the volume containing it and the appendix referred to. In the present volume this report, and general administrative affairs, occupy only 77 pages, while the appendix, containing a selection of papers (some of them original), embracing a wide range of scientific investigation and discussion, occupies more than six hundred pages. These pages consist of addresses delivered at scientific meetings, and upon other occasions, reprints and translations of contributions to scientific periodicals, and reports on some investigations carried on under the auspices of the Smithsonian Institution. There are thirty memoirs of this kind in the present report, and together they form a most interesting statement of work and progress in many branches of science.

THE additions to the Zoological Society's Gardens during the past week include two Arabian Baboons (*Cynocephalus hamadryas*, ♂ ♀) from Arabia, presented by Dr. H. O. Forbes and Mr. W. R. Ogilvie-Grant; a Rhesus Monkey (*Macacus rhesus*, ♀), a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. P. de Loriol; a Patas Monkey (*Cercopithecus patas*, ♂) from West Africa, presented by Mr. C. H. Wimpress; a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Mr. Fraser; a Nankeen Night Heron (*Nycticorax caledonicus*) from Australia, presented by Mr. John Brinsmead; two Diamond Pythons (*Python spilotes*) from Australia, presented by Mr. S. A. Michels; a Grey Lemur (*Hapalemur griseus*) from Madagascar, an Argali Sheep (*Ovis ammon*, ♂) from the Altai Mountains, deposited; four Ruddy-headed Geese (*Chloephaga rubidiceps*), bred in Holland, purchased.

OUR ASTRONOMICAL COLUMN.

COMET CHASE.—The following ephemeris for Comet Chase will be found serviceable by those who wish to observe this object. It has been calculated by Herr J. Möller, and is as follows:—

Berlin Midnight.

1899.	R.A. (app.). h. m. s.	Dec (app.). ° ′
Jan. 27	11 9 35	+33 35·9
29	9 16	33 57 9
31	8 52	34 19·5
Feb. 2	8 23	34 40·5
4	11 7 48	+35 1·0

The brightness of the comet is about the same as at the time of discovery.

NEW VARIABLE STAR IN ANDROMEDA.—Dr. T. D. Anderson announces (*Astr. Nachr.*, No. 3539) a new variable star in Andromeda, the approximate position of which for 1855 is

R.A. 2h 8m 23s ... Dec. +43° 37′·8

Using for comparison stars BD + 43°·457, 460 and 462, and estimating their respective magnitudes as 9·2, 8·8 and 9·7, he found the following values for the magnitude of this variable:—

1898 Dec. 3	...	Mag. 9·1
6	...	9·1
28	...	9·5
1899 Jan. 3	...	9·6
7	...	9·7

The star has thus rapidly decreased six-tenths of a magnitude in this short period, and it will be interesting to follow the variation further.

WITT'S PLANET (433) DQ.—The recent *Harvard College Observatory Circular* (No. 36) gives an account, with the results, of a search for the planet Witt among some negatives of star regions taken at that observatory. With the help of Mr. Chandler, who furnished an ephemeris based on the best material, Mrs. Fleming undertook the examination of the plates for the year 1894; but in the first instance, although the latter examined a region covering 1300 square degrees, the planet was not found. The next search was made upon the plates taken in 1896, as the errors of the ephemeris would not then be so great, and might possibly compensate for the extreme faintness of the planet. The result of this search was that at last a faint image was found on a plate taken on June 5, 1896, and this was confirmed on plates exposed on June 5 and 6.

From these positions the ephemeris was corrected, and positions for 1894 computed. A further examination by Mrs. Fleming brought to light impressions of the planet on several other plates taken in 1894 and 1893. In addition to the positions of the planet at the times each of these photographs was obtained, Prof. Pickering publishes in the present *Circular* an ephemeris from 1893 October 27 to 1894 April 21, computed by Mr. Chandler from a combination of the observations of 1898, and the photographs taken on December 19 and 27, 1893; February 16, 1894; April 6, 1896; and June 4 and 5, 1896.

The elements calculated by Mr. Chandler from such a combination of positions are the following:—

Elements.

Epoch 1898, August 31·5 G.M.T.

$$\begin{aligned} M &= 221^\circ\ 35'\ 45''\!\cdot\!6 \\ \omega &= 177\ \ 37\ \ 56\cdot0 \\ \Omega &= 303\ \ 31\ \ 57\cdot1 \\ i &= 10\ \ 50\ \ 11\cdot8 \\ \phi &= 12\ \ 52\ \ 9\cdot8 \\ \mu &= 2015''\!\cdot\!2326 \\ \log a &= 0\cdot1637876 \\ \text{Period} &= 643\cdot10\text{d.} \end{aligned} \qquad \left.\begin{matrix}\omega\\ \Omega\\ i\end{matrix}\right\}\ 1898\cdot0$$

It may be mentioned that further images of the planet have been found on plates taken in November 26, December 23, 1893, and in January 19, 25, 30, and February 5 of the following year.

On a previous occasion in this column (December 1, 1898, p. 108) we drew attention to a suggestion by Prof. Chandler, who gave his reasons why Pluto would be an appropriate name for this new planet. In the *Astronomische Nachrichten* (No. 3539), Dr. G. Witt, the discoverer of the planet, proposes to call it by the name Eros, hoping that this will be found suitable for such an important little body.

THE HAMBURG OBSERVATORY.—Prof. F. Küstner, the director of the observatory at Bonn, has been appointed to take over the directorship of the Hamburg Observatory, in succession to Prof. G. Rümker, who has, we are sorry to say, retired owing to prolonged illness.

THE LEONIDS IN 1898.—Several additional accounts of the observations of the Leonids at different stations are published in the *Astronomische Nachrichten* (No. 3538). Those made at Vienna and Pola seem of special interest. In Vienna the three nights of the 13th, 14th and 15th were useless for observation; but Dr. Palisa, with Herr J. Rheden, ascended the "Semmering," and were fortunate in having clear weather after midnight on the night of the 13th. Between 3h. and 5h. 30m. twenty-two meteors were seen, thirteen of which were Leonids, but all below the second magnitude. On the evening of the 14th, Prof. E. Weiss also ascended to this point, taking with him two photographic cameras. Between 3h. 15m. and 5h. 45m. about 250 meteors were seen, two-thirds of which were estimated as Leonids, and several brighter than Venus. On the photographic plates six trails were recorded, one of which belonged to an interesting meteor which was observed to be as bright as Jupiter, and came from the radiant R.A. 153° + 23°. On the night of the 15th, Dr. Palisa and Herr Rheden, observing from the same station between 10h. 45m. p.m. and 2h. 30m. a.m., saw fifty meteors, many of which were very bright, but only about twenty-five of them Leonids These observations indicate that the forerunners of the swarm reached the earth in the night of the 13th–14th, the maximum being reached probably during the day of the 15th. Prof. Weiss adds that the passage through these meteors lasted for more than twenty-four hours, suggesting

that the width of the swarm had increased very considerably since 1866.

In Pola, on the night of the 15th, the meteors seem to have been well seen, eighty-three being observed, thirty-four of which were Leonids. The maximum of the display is stated to have taken place at 16h. 48m. Pola M.T., the radiant point deduced from twenty-two of the best observations being R.A. 10h. 12m. + 26°·5.

STUDIES OF THE LUNAR PHOTOGRAPHS TAKEN WITH THE LARGE EQUATORIAL COUDÉ.[1]

THE new part of the "Atlas of the Moon," which we offer to the public to-day, presents many points of comparison with sections previously published. But, on account of changes of the moon's age and her libration, the portions common to both serve no double purpose. The comparison of the negatives, as we shall see more especially by studying Plates XV. and XVI., enables us to interpret some dark markings, to establish a finer distinction between the unevenness of the surface and the variations from the ordinary colour, and finally to determine more precisely the points where the reality of a periodic change may be presumed.

Plate *c* is the third in our publication, in which the whole of the moon, visible simultaneously from the earth and sun, is represented. This portion is here much more restricted than has already appeared in Plates *a* and *b*. The new sheet is, in consequence, less rich in detail, but derives a particularly expressive appearance, due to the rapid change from shadow to light. It is naturally the general features of the physiognomy of our satellite, the laws of distribution of plains and mountains, which can be usefully studied on these unenlarged pictures. We call special attention to the polygon form of the *Mer des Crises*, which is the best defined of all the dark plains of the moon; to the traces of progressive depressions which are presented in its central portions; to the large rectilinear valleys which are visible in the southern part of the disc; to the alignment following a meridian of the four most important circles of the southern horn; to the existence of a long series of dark spots on another meridian near the limb. We find altogether, in this part of the moon, a well-marked relation between the local appearance of the surface and longitude. This relation is interesting to note, owing to the probability of its being connected with the mechanical work of tides caused by the earth.

The three unenlarged proofs published as yet demonstrate several important facts, which are confirmed by a number of clichés in our possession. They are:—

(1) A nearly continuous progression of light, extending from the terminator to the illuminated limb, approximately coincident with the curves of equal illumination and the meridians.

(2) A recrudescence of illumination in the neighbourhood of the poles, and principally of the South Pole.

(3) A marked increased of luminous intensity in the immediate neighbourhood of the limb.

A satisfactory theoretical explanation is possible for the first law, if the moon be regarded as a uniform globe in its superficial constitution, without appreciable atmosphere, beyond the state of exercising a sensible specular reflection, and reflecting indifferently in every direction the light received. Under these conditions the formula which expresses the relative intensity, and which will be found in the note relating to Plate *c*, indicates that the curves of equal illumination are the meridians, and that the intensity must increase from the terminator to the limb.

The slight exception to this rule, which is apparent near the poles, already attracted our attention when we described Plates I., II. and VI. We there saw the proof that these portions of crust very soon became solidified and rapidly acquired a great thickness. By this the polar caps have escaped the inundations originating from the interior, which have changed the appearance of the equatorial region. They are found to receive more rapidly the deposits of white cinders of the volcanic period, chief cause of the difference of tints which we observe to-day.

One may attempt to go further back, and to account for the early solidification of the polar regions. It is evident, to begin with, that the cooling must progress more quickly under the influence of a less efficient solar radiation. We will add that the tides of terrestrial origin caused smaller oscillations than in the equatorial regions, and having a slower velocity of propagation. The congealing of the superficial scoriæ is, therefore, much more easily effected near the poles.

The third fact, that is to say the abnormal increase of luminosity near the limb, merits more attention, because it is not the result of the mode of operation adopted, which, on the contrary, would be of a nature to weaken it. It shows itself in every latitude, and in all phases. In particular, the photographs taken during the partial eclipse of January 7, 1898, show that the increase of intensity on the edge is still very appreciable at opposition—that is to say, at the moment when calculation would assign a uniform brilliancy to the lunar disc.

It seems that no purely geometrical theory accounts for this appearance if it is not supposed that it is really connected with the physical state of the surface—that is to say, that not only the polar caps, but all the regions which form the apparent "contour" of the moon are, collectively, of a lighter colour than the other parts of the disc.

Here, again, the tides of terrestrial origin, already studied from other points of view by MM. Faye and Poincaré, appear to have played an essential part. Their character is entirely modified, since the day when the rotation of the moon upon its axis was equal to the period of revolution. The periodical flow, which formerly invaded the whole equatorial region, finished by accumulating in the portion of the disc which the earth sees at the present day near its zenith. Besides this our globe, still incandescent, was really a source of great heat for its satellite. The regions near the limb have therefore entered, in their turn, into this period of low temperature and relative calm which is favourable to the consolidation of the polar regions.

The real characters of the high latitudes, already notified in the previous part, can be more completely studied here on Plates XIII. and XVII. The latter shows us the South Pole covered with mountains, varying in height from 6000 to 7000 metres, the highest that have been measured on the moon. These depths are not entirely due to the hollow of the walled plains. Although very numerous, sufficient space is left between them to allow us to judge of what was the previous contour. It can be seen that it comprised very high ridges which the craters have encroached on without destroying, and without themselves losing the regularity of their contour. There have thus been formed between the different parts of the same enclosure, differences of level which mount up to 1500 or 2000 metres. The most elevated points, which seem to correspond to a very thick crust, and capable of offering great resistance are, on the contrary, often full of little craters. The general appearance of the region gives rise to the thought, as we have already said of Plate VI., that there does not exist a covering of ice at the poles, and that it has not produced an active erosion there.

If we now consider Plate XIII. in the neighbourhood of the North Pole, we see the walled plains occupying a still more secondary place. Here the seas advance to very high latitudes. Long mountainous masses exist between them, as, for instance, the Alps and the Caucasus. These ranges, situated at a higher level than that of the seas, are strewn with summits presenting well-marked alignments, but no sign of ramified valleys, and very little circular formation. They are broken up into several fragments by rectilinear fissures, of which the great valley of the Alps constitutes the most celebrated and best example. The portions thus separated seem to have undergone sliding movements in relation to one another. Considerable difference of level is manifested in one *massif*, in such a manner that it ends at one side by a very high and very steep descent, while the other descends insensibly to the seas. The signs of primitive level have no other common feature with the terrestrial mountains than their great relative altitude, and prolonged atmospheric agencies would be necessary to make them acquire new features of resemblance with them. If the North Pole is approached, it will be seen that at the surface a net-work of furrows are formed in such a manner as to produce rectangular basins. The higher the latitude, the more important these movements of the ground become; and it is credible that, if we could see past the apparent contour of the moon, we would observe a relief comparable with that of the South Pole. The undeniable difference which to-day exists between the appearance of the two poles is favourable to the views of G. H. Darwin and other geometers, who estimate, for reasons derived from celestial mechanics, that

[1] Translation of a paper by MM. Lœwy and Puiseux. (Published by the Paris Observatory.)

the inclination of the axis of rotation of the moon to the plane of the orbit has undergone important variations.

In order to understand the mechanism of the depressions which have caused the seas, the phenomena must be seen at different stages of advancement, and for this purpose it is necessary to study in detail how the transition between the great southern cap, which is mountainous, and the plains of the equatorial region have been effected. This passage may be studied on Plate XIV., of which nearly half, occupied by the *Mer des Nuages*, indicates numerous obliterated or submerged formations. The traces of the most ancient depressions have naturally disappeared by the overflowing of lava, but the more modern depressions on a dry and resisting crust, often allow their contour and size to be recognised. Some of these are connected to the central portions of the seas, leaving a great exterior band joining the mountains, which serve at the same time as limit and fulcrum. The two portions of crust thus disjointed have only been able to acquire a relative movement in a vertical direction. The part which remained immovable constitutes, in relation to the other, a sort of raised terrace. Thus must be interpreted the celebrated formation known by the name of "The Straight Wall." As the same map shows it us a little distance off, the rupture can also be accompanied by a tangential slip. It appears then like a large crevice, similar to those we saw appearing to the east of Hesiod. These fissures may be connected with large portions of the crust, may even divide chains of hills, and their form, generally rectilinear, seems independent of all the small inequalities of the surface.

It can easily be understood that such crevices rarely acquire dimensions large enough to be visible from our earth. Further, it is only near the boundaries of the seas that they have a chance of remaining open. In the central parts, the submersion of the surface has made every vestige disappear. The zones near the limb are also, by reason of the variations of the interior pressure, subject to encroachments of lava. But these inundations, which are not so frequent, are not uniformly distributed. They give rise to solid accumulations along the crevices from which they issue, and they take the form of swollen nerves. Two of these net-works can be studied in the present—and third—part; one stretching to the west of Bouillaud (Plate XIV.), the other between Landsberg and Wichmann (Plate XV.). In this last system we see a large region composed alternately of hollows and hills, as if to enable us to note the change.

The evidence of volcanic action appears here with an amplitude, a clearness, which leaves little to be desired. We have had to content ourselves with a somewhat smaller enlargement in order to comprise in two consecutive pages (Plates XV. and XVI.) the largest portions of these brilliant aureoles, that are seen shining round certain walled plains, as Lalande, Kepler, or Copernicus. It seems to us that the comparison of these two pages is very suggestive. One is convinced by it that the diverging trails, becoming invisible by a very oblique illumination, cannot be interpreted as inequalities of the surface. Intersecting valleys and mountains without becoming fainter or deviating from their course, they cannot have been produced by subterranean or superficial means. An atmosphere agitated by variable currents seems to be the only cause which can explain the diffusion of tracks to such distances. This hypothesis further agrees with what we know of the extreme tenuity of volcanic dusts, with their capability of remaining for a long time in suspension in very thin air. It is strengthened by the fact of the existence of a relatively dark corona round the principal centres of luminosity. It is possible that in a certain zone round the more recent craters, like the region in the neighbourhood of terrestrial volcanoes, the largest projectiles, the streams of lava have got mixed in the deposits of cinders, and have not allowed them to remain clearly visible near these orifices.

Without misunderstanding the evident unity of origin of these tracks of a same system, one might be surprised to see their direction, their size, and their brightness sometimes undergoing sudden changes without clear relation to the distance of the central crater. Two disturbing causes seem to interfere: one is the meeting of high mountains, capable of dividing the atmospheric currents, of causing downfalls, and abundant condensation. The other, more frequent and more efficient, is the presence of hollow basins, still liquid at the time the downfalls of cinders took place, useless in consequence of receiving or keeping superficial deposits. The tracks, therefore, behave in the plains like a very sensitive reagent, being able to disclose by a recrudescence of brightness the smallest unevenness of the surface, and, by a sudden weakening, the slowly solidified lagoons. The comparative examination of a similar region, described in the Plates XV. and XVI. under contrary conditions, furnished numerous facts in support of this idea.

Are some of these deep basins still imperfectly dry, and will their physical state consequently be changed by a prolonged exposure to the solar rays? The green and red tints that are seen in the neighbourhood of the terminator, in the interior of some walled plains, make one think that this is so. The eye being more sensitive in the appreciation of tints, photography has the advantage of the impartial registering of relative luminous intensities, It has, without contradiction, the right to bring its evidence into the question. Plate XVII., which represents a region where the sun is setting, must be compared from this point of view with Plate I., where the sun is rising on the same parts. We find these dark spots of even tone, which in the interval have obviously modified their tints relatively to the neighbouring plateaus. The reality of this change has been confirmed by the examination of a series of clichés arranged in intermediate phases.

Below we sum up the principal ideas which this third part suggests or confirms, and which one will find developed in the following pages containing the description of the different plates. They are:—

(1) The explanation of the relative stability and the mountainous character of the polar caps.

(2) The extension of these same characters to every region which form the apparent limb.

(3) The geometric reason of the approximate coincidence that one sees between the curves of equal illumination on the disc and meridians.

(4) The origin of the abnormal recrudescence of luminosity which is shown at the apparent limb in contradiction to calculation.

(5) The difference of constitution of the two poles seems to indicate that the axis of rotation has undergone great displacements in the interior of the planet.

(6) The cause of the predominance of the seas in equatorial regions.

(7) The interpretation of the different tints that are apparent in the tracks; the use of the dark spots to recognise, amongst the sunken basins of the lunar surface, those which have been the last to solidify.

Results of equal interest can apparently be deduced from the fourth and fifth parts, the materials of which we have in hand. We hope the studious public will not have very long to wait for the rest of this work, for it has indeed been good enough to see in the two first parts an appreciable addition to our selenographic knowledge. However, we do not doubt that it is possible to do more, and also better; for if we think we have brought the methods of reproduction to the desired degree of perfection, it is not the case in the execution of direct photographs, which remains, by reason of the habitual movement of the images, a very difficult operation. A single cliché, available for enlarging, represents practically for us the only result of several months' work, and in certain phases our best proofs betray, in a very apparent way, the unsteadiness of the atmosphere.

OYSTERS AND DISEASE.[1]

THIS research was commenced three years ago, and has been carried on intermittently in the intervals of other work.

Preliminary reports on some of our results have been laid before the British Association at the Ipswich, Liverpool, Toronto, and Bristol meetings, and a short paper on one section of the subject was communicated to the Royal Society and printed in the *Proceedings* last year. In the present paper we give a full account, with illustrations, of the detailed evidence upon which our various conclusions are based. The following is a brief statement of the more important results given in the paper:—

(1) Although our primary object was to study the oyster under unhealthy conditions, in order to elucidate its supposed connection with infective disease, we found it necessary to study

[1] "Observations upon the Normal and Pathological Histology and Bacteriology of the Oyster." By Profs. W. A. Herdman, F.R.S., and Rubert Boyce. (Abstract of a paper read before the Royal Society, January 19.)

in minute detail the histology of certain parts of the body, especially the gills and mantle lobes, the alimentary canal and liver. We give figures and descriptions of these structures in both normal and abnormal conditions.

(2) We have also worked out the distribution and probable function of a minute muscle, which we believe to be the modified representative of the protractor pedis muscle of some other molluscs.

(3) A diseased condition we found in certain American oysters very soon brought us into contact with the vexed question of the "greening" of oysters, and one of the first results we arrived at was that there are *several distinct kinds* of greenness in oysters. Some of them, such as the green Marennes oysters, and those of some rivers on the Essex coast are healthy; while others, such as some Falmouth oysters, containing copper, and some American oysters re-bedded on our coast, and which have the pale-green "leucocytosis" described in our former paper to the Royal Society, are not in a healthy state.

(4) Some forms of greenness (*e.g.* the leucocytosis) are certainly associated with the presence of a greatly increased amount of copper in the oyster, while other forms of greenness (*e.g.* that of the Marennes oysters) have no connection with copper, but depend upon the presence of a special pigment, "marennin."

We are able, in the main, to support Ray Lankester in his observations on Marennes oysters; but we regard the wandering amœboid granular cells on the surface of the gills as leucocytes which have escaped from the blood spaces, and have probably assumed a phagocytic function.

(5) We see no reason to think that any iron which may be associated with any marennin in the gills, &c., is taken in through the surface epithelium of the gill and palps, but regard it, like the rest of the iron in the body, as a product of ordinary digestion and absorption in the alimentary canal and liver.

(6) We do not find that there is any excessive amount of iron in the green Marennes oyster compared with the colourless oyster, nor do the green parts (gills, palp, &c.) of the Marennes oyster contain either absolutely or relatively to the colourless parts (mantle, &c.) more iron than colourless oysters. We therefore conclude that there is no connection between the green colour of the "Huîtres de Marennes" and the iron they may contain.

(7) On the other hand, we do find by quantitative analysis that there is more copper in the green American oyster than in the colourless one; and more proportionately in the greener parts than in those that are less green. We therefore conclude that their green colour is due to copper. We also find a greater quantity of iron in those green American oysters than in the colourless; but this excess is, proportionately, considerably less than that of the copper.

(8) In the Falmouth oysters, containing an excessive amount of copper, we find that much of the copper is certainly mechanically attached to the surface of the body, and is in a form insoluble in water, probably as a basic carbonate. In addition to this, however, the Falmouth oyster may contain a much larger amount of copper in its tissues than does the normal colourless oyster. In these Falmouth oysters the cause of the green colour may be the same as in the green American oyster.

(9) By treating sections of diseased American oysters under the microscope with potassium ferrocyanide and various other reagents, we find that the copper reactions correspond in distribution with the green coloration; and we find, moreover, from these micro-chemical observations that the copper is situated in the blood-cells or leucocytes, which are greatly increased in number. This condition may be described as a green leucocytosis, in which copper in notable amount is stored up in the leucocytes.

(10) We find that an aqueous solution of pure hæmatoxylin is an extremely delicate test for copper, just as Macallum found it to be for iron.

(11) Experiments in feeding oysters with weak solutions of various copper and iron salts gave no definite results, certainly no clear evidence of any absorption of the metals accompanied by "greening."

(12) Although we did not find the *Bacillus typhosus* in any oysters obtained from the sea or from the markets, yet in our experimental oysters inoculated with typhoid we were able to recover the organism from the body of the oyster up to the tenth day. We show that the typhoid bacillus does not increase in the body or in the tissues of the oyster, and our figures indicate that the bacilli perish in the intestine.

(13) Our experiments showed that sea-water was inimical to the growth of the typhoid bacilli. Although their presence was demonstrated in one case on the twenty-first day after addition to the water, still there appeared to be no initial or subsequent multiplication of the bacilli.

(14) In our experiments in washing infected oysters in a stream of clean sea-water the results were definite and uniform; there was a great diminution or total disappearance of the typhoid bacilli in from one to seven days.

(15) The colon group of bacilli is frequently found in shell-fish as sold in towns, and especially in the oyster; but we have no evidence that it occurs in mollusca living in pure sea-water. The natural inference that the presence of the colon bacillus invariably indicates sewage contamination must, however, not be considered established without further investigation.

(16) The colon group may be separated into two divisions: (1) those giving the typical reactions of the colon bacillus, and (2) those giving corresponding negative reactions, and so approaching the typhoid type; but in no case was an organism giving all the reactions of the *B. typhosus* isolated. It ought to be remembered, however, that our samples of oysters, although of various kinds and from different sources, were in no case, so far as we are aware, derived from a bed known to be contaminated or suspected of typhoid.

(17) We have shown also the frequent occurrence, in various shell-fish from the shops, of anaerobic spore-bearing bacilli giving the characteristics of the *B. enteritidis sporogenes* recently described by Klein.

(18) As the result of our work, we make certain recommendations as to the sanitary regulation and registration of the oyster beds, and as to quarantine for oysters imported from abroad.

THE DUKE OF DEVONSHIRE ON SECONDARY EDUCATION.

THE Duke of Devonshire opened the new building of the Municipal Technical College at Derby on Thursday last; and in the course of an address delivered at a luncheon given by the Mayor of Derby on that occasion, he is reported by the *Times* to have made the following remarks upon the value of scientific instruction and the reform of secondary education.

The inhabitants of Derby had not up to the present time enjoyed all the advantages in obtaining a scientific education which would have been so useful to a town possessing so many, so large, and so varied industries. But science instruction in Derby was now, he trusted, entering upon a new course, and he had little doubt that the instruction in science which would be carried on in that building would be as thorough as that which had hitherto been accomplished in the art school. Though they had made a great step in the erection and completion of these buildings, a great deal still remained to be done. The erection of the most complete buildings and the calling of them a college would not be of much use unless at the same time they were able to obtain a competent staff of teachers. That, he had no doubt, had already been done; but, even when they had done that, they must remember that independent classes and courses of lectures, useful as they might be in enabling students to acquire certain branches of knowledge which would be of use to them in future years, would not, unless they were organised on the principles to some extent which prevailed in our older schools and colleges, provide that intellectual training and that mental discipline which was more valuable than any acquired knowledge.

He and many with him, much more able than himself, had during a good many years advocated the absolute national necessity of giving to our people a better technical, artistic, and scientific training. He had urged it in the interests of the maintenance of our industrial supremacy and in the interests of our industrial and commercial existence. The necessity for placing these means of technical instruction within the reach of our people was now universally admitted. There was a movement in this direction in every part of the country, and, in addition to what had hitherto been known as the technical education movement, there was an equally strong desire for the addition of what was termed commercial education. But what

he thought was not yet quite clearly understood, and what he felt he had hitherto failed to understand himself more than in a very imperfect degree, was that we could not have technical, scientific, or artistic training to any great extent or in any valuable degree except as part of a sound general system of secondary education. We could not graft scientific or artistic education upon the stunted stem of deficient elementary education. On the other hand, he believed that the special study and development of a sound general system of education would be found to be of great and daily-increasing advantage. For this reason he had seen with great satisfaction that a good deal of attention had been paid during the last few weeks to a measure which he had laid before Parliament last year for the purpose of obtaining discussion and criticism, and which he hoped. either in its former or in an altered shape, to introduce again very shortly into Parliament with a view to its passage. The object of that measure was to commence—it did not profess to do more—the reform and reorganisation of our secondary education.

If the provisions of the Bill were of a limited character, and were confined to the creation of a central educational authority, it was because the Government were of opinion that it was best and wisest to proceed by degrees and with precaution, and to put their own house in order before they attempted to arrange the houses of other people. They admitted that a great deal of the confusion and want of co-operation which existed locally found its counterpart in the central departments in the metropolis between the Charity Commissioners, the Endowed Schools Commissioners, the Education Department, and the Science and Art Department. There had not hitherto been that unity of action and that thorough common understanding of objects and aims which would enable those Departments to give sound and practical advice to the local authorities. The Government believed that if they succeeded—and they hoped to succeed—in uniting these educational authorities at the centre into one harmonious and powerful organisation, then, without attempting to impose upon the country any cast-iron system, while leaving to localities perfect freedom to adapt their own educational methods to their own ends, they would be able to afford them through their experts and their inspectors that assistance and guidance which would enable them to carry out efficiently their important duties.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Vice-Chancellor publishes a further list of donations to the Benefaction Fund, established last year, which brings the total up to 8557*l*. The list includes a donation of 1000*l*. from Lord Iveagh. Prof. Ewing has also received a promise from an anonymous donor of 500*l*. to be expended on apparatus for the Engineering Laboratory.

The Agricultural Science Syndicate reports that twenty-one candidates have now received the University diploma in Agriculture. Of these fourteen have studied in Cambridge: seven are now engaged in teaching, and seven in farming or land agency.

CLIFTON COLLEGE has achieved remarkable success in the recent examination for admission to Woolwich and Sandhurst, the first place in each list having been gained by a Clifton boy direct from school. This is the first examination held under the new syllabus, which was so severely criticised in the papers about two years ago. Though materially reduced, the scheme still remains the most exacting that has yet been proposed to army candidates.

THOSE who are working in the cause of higher education among the Mahomedans have (says the *Allahabad Pioneer Mail*) been much encouraged by a letter that Mr. Justice Budruddin Tyabjee, of Bombay, has addressed to the Nawab Mohsin-ul-Mulk, in reference to the scheme for raising the College at Aligarh to the status of a Mahomedan University. The learned judge, who so worthily represents Mahomedan culture and enlightenment in his own Presidency, has expressed warm approval of the idea, and has supported his approval with an offer of a subscription of 2000 rupees towards the endowment fund.

PROF. W. A. HERDMAN, F.R.S., remarks in the twelfth annual report of the Liverpool Marine Biology Committee that there are two practices in American universities which excite the envy of professors in this country. One is the "sabbatical year"—the one year in every seven given for purposes of travel, study, and investigation. The other is the frequent endowment of an expedition—or equipment of an exploring party—by an individual man or woman who is interested in the subject, and can give a special fund for such a purpose. The Columbia University in New York, the Johns Hopkins University in Baltimore, Yale College in Newhaven, and Harvard at Cambridge, have all benefited immensely in the past by such exploring expeditions. Nearly every year of late has seen one or more of such, due to private generosity, in the field; and the work they have done has both added to general scientific knowledge, and has also enriched with collections the laboratories and museums of the college to which the expedition belonged.

THE absurd mistakes made by school children in writing answers to examination questions are often due to imperfect teaching, and they point to the need of more rational methods of instruction. The *University Correspondent* publishes a classified collection of these mistakes annually, and from the list that has just appeared we select a few, not in a spirit of levity, but to warn teachers who instruct children in the principles of science to be sure that their pupils comprehend their lessons. In geography the following answers occur:—The North Pole is a stick put in the ground by the explorer who can go farthest north.—A delta is a burning mountain.—If you stand on the seashore on a clear day, you can watch a vessel sailing round the world. This is a proof that the world is round.—The Sunderbunds are the hot winds which blow across the desert of Sarah.—Cañons are pieces of rope the Americans catch wild horses with.—A moraine is a disease which afflicts cattle in hot countries. The following answers, classified under mathematics and science, are amusing:—A trapezium is the thing in a gymnasium.—Elements are those metals which do not combine with other things, such as earth, alumium, water, fire, air, &c.—Latent heat is little particles of steam joined together so as you can't see them.—The solar spectrum is a group of stars so called in consequence of its being nearer the sun than any other group.—The stomach is the most diluted part of the elementary canal.—Wind is that which the dust blows along the street.

MR. JAMES STUART, M.P., delivered an address at St. Andrews University on Monday, the occasion being his installation as Rector of the University. In the course of his remarks he pointed out that much of the trade and commerce of the country was now under conditions in which the knowledge it was based on could be with advantage submitted to ordinary scientific treatment. But trade and commerce were still outside the pale of their University system, and those who followed them had to content themselves with the crumbs which fell from other tables. From the Universities' own point of view it daily became more necessary to provide new outlets for their students. There was undoubtedly an increased and increasing demand by those who wanted to learn that they should be taught subjects which bore upon their every-day life—sanitary science, physiology, anatomy, geology, chemistry of the arts, electricity, political economy, the history of trade and of their colonies, and modern languages. Many wanted those things who did not care for Latin or Greek or pure mathematics, and it would not do for the Universities to sit down and say, "We will not teach you these things because they are not academic subjects." They should not fear the curriculum being too full; students could always select for themselves what they wanted to study, and they ought to strive to give men wide chances of knowing what the state of knowledge was. There was more spent on trade and manufacture in some single towns in Germany now than in all broad Scotland put together. Their education in trade and manufacture was miserably behind, and yet this was at a moment when everything in the national race depended on such education. No one who had compared the advance of Germany in education with their own stagnation, even during the last quarter of a century, could fail to tremble at the insecurity in which this nation stood. It was his opinion, as one who had watched this for long, that it was not too much to say that commercial and trade decay lay before them unless they could pull themselves together in this matter They pottered over night schools, and this or that piece of technical teaching. They were altogether on a wrong scale. Where their competitors were spending thousands of pounds they were spending dozens of half-pence.

SCIENTIFIC SERIALS.

Memoirs of the Kazan Society of Naturalists, vol. xxxii. 1, 2, 3.—The fauna of the Eocene deposits on the Volga between Saratov and Tsaritsyn, by A. Netschaev, with ten plates. These deposits were formerly described as Cretaceous. It was Prof. Sintsoff who determined their Palæocene age, and established their subdivisions, lately confirmed and further studied by Prof. Pavloff. The author describes 170 species from his own collections, out of which species no less than 80 are new, or are described as such. Three subdivisions of the deposits are established, corresponding to the following subdivisions previously described: (*a*) the sands Pg_1c of Sintsoff, or Lower Sarmatian, of Prof. Pavloff, which would correspond to the Suessonien of Western Europe, or to the Thanet Sands of Great Britain: *b*) the Glauconite sandstones, Pg_1a' of Sintsoff, or Upper Syzrañ of Pavloff, and the Glauconite clays and sandstones, Pg_1a of Sintsoff, or Lower Syzrañ of Pavloff, the latter overlying and gradually passing into the Cretaceous strata. On the whole, these Eocene strata bear resemblance to the Anglo-Gaelic deposits of the same age, but totally differ from the Eocene deposits of South-west Russia. The Palæocene Volga Sea must have been a large sea extending northwards up the present lower Volga, and westwards as far as the meridian of Penza. In the East, it reached the foot of the Southern Urals. This sea was a remainder from a much larger Cretaceous sea, which covered a large part of European Russia. The Middle and Upper Eocene sea which covered South-west Russia must have been independent from the former.—Materials for the flora of the Buzuluk district of Samara, by D. Vanishevsky. A list of 644 phanerogam species is given.—On the deformed skulls found in the Siberian burial mounds (*Kurgans*), by S. Tschugunoff (with one plate). This is the ninth note of the author's "Materials for the Anthropology of Siberia," the first eight notes having been published in the *Proceedings* of the Tomsk University, parts vi., vii. and x. The author describes two macrocephalic deformed skulls which were found in the Kainsk district of Tomsk, as well as three others of the same type from the Crimea.

Bollettino della Società Sismologica Italiana, vol. iii., 1897, No. 5.—Obituary notice of M. S. de Rossi, by A. Cancani.—Principal eruptive phenomena in Sicily and the adjacent islands, January-June 1898, by S. Arcidiacono.—Elastic pendulum to act mechanically on the *Galli-Brassart* informer, by C. Guzzanti. The new arrangement consists of a pendulum, the movement of which, magnified by a lever, stops the clock of the informer.—The Turkestan earthquakes of August 15 and September 17, 1897, by G. Agamennone.—List of earthquakes observed in Greece during the year 1895 [first half], by S. A. Papavasiliou: a list of about 250 shocks, nearly one-half of which were felt in the island of Zante.—Notices of earthquakes recorded in Italy (September 21–October 2, 1897), by G. Agamennone, the most important being the Ancora earthquake of September 21.

Memoirs of the Society of Naturalists of St. Petersburg: Mineralogy and Geology, vol. xxiv.—Geological observations in the valleys of the Urukh, Ardon, Malka, and the neighbourhoods of Kislovodsk, by M. Karakash. The above valleys are occupied in their upper parts by granites and crystalline slates, followed by palæozoic clay slates. Granites crop out next, once more, and are covered with Lower and Upper Cretaceous deposits, followed further northwards by Tertiary deposits. Near Kislovodsk, Senonian, Albian, Aptian, and Lower Neocomian deposits were found.—The fauna of the Jurassic deposits of Mangyshlak and Tuar Kyr (Transcaspian region), by B. Semenoff, being a study of the fossils collected by Prof. Andrusov in that very little explored region (with plates). The fossils belong to the Callovian age. At Tuar Kyr two new species (*Macrocephalites Andrussowi* and *Peltoceras retrocostatum*) were discovered, as also two Himalayan species (*Cosmoceras Theodorii*, Opp., and *Peltoceras cf. Ruprechti*, Opp.) This discovery would seem to give support to Neumayr's idea as to the Jurassic basins of West Europe and Russia having been connected with the Himalayan sea through a Transcaspian basin.—On geological researches made in 1895 in the government of Baku and on the Eastern coast of the Caspian Sea, by N. Andrusov.—New data relative to the fauna of Jurassic deposits in Orenburg, by B. Semenoff. They are based on the collections kept at the St. Petersburg University. Twenty-eight supra-Jurassic Ammonites (26 *Perisphinctes* and 2 *Aspidoceras*) were studied; they belong to various ages, from the Upper Oxfordian to the Tithonian age.—All papers are fully summed up in French or in German.

Memoirs of the St. Petersburg Society of Naturalists: Botany, vol. xxvii. Parts 2 and 3.—These two Parts are almost entirely given to larger works relative to local floras: the flora of the Polyesié (the Woodlands of West Russia), by I. Pachossky, followed by a note on the Woodlands of Volhynia, by S. Fedoséeff; the flora of the government of Pskoff, by N. I. Puring (with map), followed by a note by E. Ispolatoff; and a paper on the flora of Novgorod, by A. I. Kolmovsky.—A note on the structure of the stem of *Gypsophila aretioides* by V. Dobrovlyansky, with two very interesting photographs.

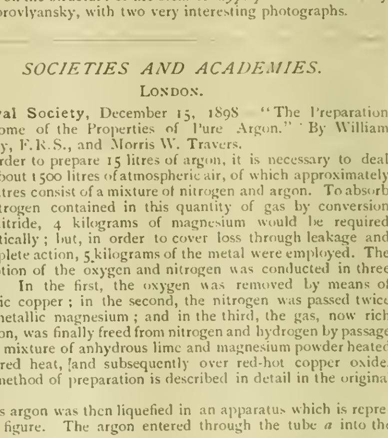
SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 15, 1898. "The Preparation and some of the Properties of Pure Argon." By William Ramsay, F.R.S., and Morris W. Travers.

In order to prepare 15 litres of argon, it is necessary to deal with about 1500 litres of atmospheric air, of which approximately 1200 litres consist of a mixture of nitrogen and argon. To absorb the nitrogen contained in this quantity of gas by conversion into nitride, 4 kilograms of magnesium would be required theoretically; but, in order to cover loss through leakage and incomplete action, 5 kilograms of the metal were employed. The absorption of the oxygen and nitrogen was conducted in three stages. In the first, the oxygen was removed by means of metallic copper; in the second, the nitrogen was passed twice over metallic magnesium; and in the third, the gas, now rich in argon, was finally freed from nitrogen and hydrogen by passage over a mixture of anhydrous lime and magnesium powder heated to a red heat, [and subsequently over red-hot copper oxide. The method of preparation is described in detail in the original paper.

This argon was then liquefied in an apparatus which is repre- in the figure. The argon entered through the tube *a* into the



bulb *b*, of some 25 c.c. capacity, surrounded by liquid air contained in a double-walled vacuum jacket. The air was made to boil under a low pressure of a few centimetres of mercury by means of a Fleuss pump attached to the tube *c*. The argon rapidly and completely liquefied to a colourless mobile liquid: it showed no absorption spectrum. Its volume was about 17·4 c.c. By turning the tap *d* it was placed in communication with the first of the series of mercury gasholders, *e*; the reservoir was then lowered so as to remove the lower-boiling portions of the liquid. During this distillation, which took place at constant temperature, the pressure on the boiling air was kept as low as possible. This gas subsequently turned out to be rich in neon, and to contain helium (*Roy. Soc. Proc.*, vol. lxiii. p. 437). The remainder of the argon boiled back into the main gasometer until the last few drops were left; the residue solidified, and finally gave a gas to which we gave the name metargon; it was collected in mercury gasholders (*loc. cit.*, p. 439). As will be subsequently shown, the krypton and xenon in this quantity of argon are too minute for detection. A similar operation for the purpose of separating the lighter as well as the heavier constituents was afterwards repeated three times, the middle portion of argon being always returned to the main gasholder. A fourth

liquefaction was carried out in which six mercury gasholders were filled with six separate fractions of argon, each taken after each successive fifth of the total argon had evaporated. These fractions were next purified from any nitrogen accidentally present by sparking with oxygen over caustic potash. After the removal of the oxygen the density was determined.

Density of Argon.

For a preliminary determination of the density of the various samples a bulb of about 33 c.c. capacity was employed. It is much easier to ensure the purity of a small sample of gas than of a large one; and it will be seen that very concordant determinations are obtainable with a small quantity. The limit of error is probably not greater than one part in a thousand. The results are expressed in terms of O = 16.

	Capacity of bulb. c.c.	Temp.	Pressure. mm.	Weight. gram.	Density.
(1)	32·762	19·05°	535·1	0·03786	19·65
(2)	,,	15·70	712·0	0·05265	19·95
(3)	,,	17·00	662·2	0·05012	19·95
(4)	,,	14·55	749·8	0·05460	19·91
(5)	,,	15·60	740·4	0·05389	19·97
(6)	,,	16·15	760·2	0·05501	19·95

The spectrum of No. 4, examined later, showed a trace of nitrogen; the density of No. 6 was confirmed by other two determinations, each made after further sparking.

No. 1 was the first portion boiled off, and therefore its density is lower than that of the other fractions, probably owing to its still containing some neon and helium. The rest of the samples have a constant density, approximately 19·95.

A larger quantity of No. 5 was then purified by long-continued sparking, and its density was determined in a bulb of greater capacity. To show the influence of such purification, results are given, obtained before it was complete. The gas under such conditions showed a trace of the nitrogen spectrum. The portion last weighed was spectroscopically pure.

Capacity of bulb. c.c.	Temp.	Pressure.	Weight.	Density.
163·19	15·47°	767·1	0·27235	19·935
,,	16·97	764·8	0·26985	19·914
,,	13·34	742·8	0·26591	19·952
,,	12·95	741·3	0·26586	19·961

After the first of these determinations the gas was passed over a mixture of red-hot magnesium and lime, and subsequently over red-hot copper oxide, in order to remove hydrogen. But after determining the density, the gas was examined spectroscopically, and was found to contain hydrogen. The gas was therefore again sparked, when the density 19·952 was found. This specimen was also examined spectroscopically, and was found to be absolutely free from all visible traces of impurity. The last weighing refers to the same sample of gas, and was made as a control experiment.

These results conclusively prove that the density of argon, purified from its companions, does not differ greatly from that obtained by Lord Rayleigh, viz. 19·94, nor by one of us, viz. 19·941. The true density may, we think, be safely taken as the mean of the last two determinations, viz. 19·957.

This corresponds with the mean of the four trustworthy determinations with the small bulb, viz. Nos. 2, 3, 5, and 6, which is 19·955.

Refractivity of Argon.

The refractivity of pure argon was next determined. The measurements were made according to the plan suggested by Lord Rayleigh (*Roy. Soc. Proc.*, vol. lix. p. 201). The samples investigated were Nos. 1, 2, 5, and 6. The comparison was made with air.

(1) 0·9620 Contains neon and helium.
(2) 0·9687
(5) 0·9647 Mean, 0·9665.
(6) 0·9660

The refractivity of a previous sample of argon, obtained from the middle of the 15 litres, during the second liquefaction, was 0·9679, a number differing only slightly from that given above.

The refractivity of argon containing krypton, which had a density 20·01, was much higher than the number given above for pure argon, for it reached 1·030 as a mean of two determinations. Evidently then the body possessing the high refractivity was not present in No. 6 in greater proportion than in No. 2, otherwise the refractivity of No. 6 would have shown an increase over that of No. 2.

The refractivity of pure argon differs somewhat from the value for crude argon found by Lord Rayleigh, viz. 0·961 (*Roy. Soc. Proc.*, vol. lix. p. 205), and also from that previously found by ourselves, 0·9596. The removal of neon, which appears to have a very low refractivity, and of helium, of which the refractivity is 0·1238, accounts for the increased refractivity of a sample from which they are absent. The gases which we have recently found in air and in crude argon will form the subject of a future communication. Suffice it to say that the amount of neon and helium is much more considerable than that of the others, and that their effect on crude argon is, therefore, much more marked on its density and refractivity.

The change in its physical constants, caused by the mixture of more recently discovered gases which it has been shown to contain, is therefore exceedingly small, and does not call for any serious alteration in the original paper on "Argon, a new Constituent of the Atmosphere."

The Density of Argon at the Boiling Point of Oxygen.

In an addendum to the original paper on argon (*Phil. Trans.*, A, 1895, p. 239), the expansion of argon by rise of temperature to 250°, as well as its contraction by fall of temperature to −88°, was determined. There is a considerable difference between the temperature at which nitrous oxide boils and that at which oxygen boils, and it was thought worth while to ascertain whether argon behaves as a normal gas down to the boiling point of oxygen. Olszewski (*loc. cit.*, p. 257) gives the boiling point of argon as −187°, and that of oxygen as −182·7; at the latter temperature, therefore, argon would not be far removed from its own condensing point. The interesting question, of course, is the possible polymerisation of argon at such a low temperature.

No sign of any polymerisation has been observed, as is shown by the following data:—

Temperature. °C.	Pressure. mm.	Volume.	R.
Hydrogen Thermometer.			
99·7	1091·5	1·0026	2·9362
0·0	803·2	1·0000	2·9421
−182·7	269·6	0·9953	2·9715
Argon Thermometer.			
100·1	1414·9	1·0026	3·8095
0·0	1040·0	1·0000	3·8022
−182·7	353·2	0·9953	3·8930

No correction has been made for the unheated or uncooled stem of the thermometer; but it is obvious that although the lowest temperament lies close to the boiling point of argon, the ratio of the values of PV/T of hydrogen and argon at that temperature, as well as the others, is practically constant.

"On the Boiling Point of Liquid Hydrogen under Reduced Pressure." By James Dewar, F.R.S.

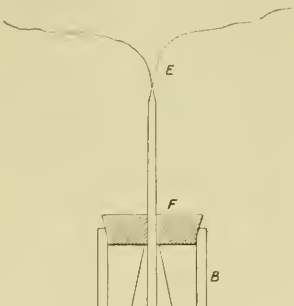
The June number of the *Proceedings* of the Chemical Society contains a paper by the author on "The Boiling Point and Density of Liquid Hydrogen." A resistance thermometer made of fine platinum wire, called No. 7 Thermometer, was used in the investigation. It had been carefully calibrated, and gave the following resistances at different temperatures:—

Temperature.	Resistance. Ohms.
+99·1° C.	7·337
+75·3	6·859
+51·4	6·388
+25·7	5·857
+0·7	5·338
−78·2	3·687
−182·6	1·398
−193·9	1·136
−214·0	0·690

These numbers suggest that with the resistance reduced to zero, the temperature registered by the thermometer ought to be −244° C. At the boiling point of hydrogen, therefore, if the law correlating resistance and temperature can be pressed to its limits, a lowering of the boiling point of hydrogen by 5° or 6° C. would produce a condition of affairs where the platinum would have no resistance, or become a perfect conductor. Now we have every reason to believe that hydrogen, like other liquids,

will boil at a lower temperature the lower the pressure under which it is volatilised. The question arises, how much lowering of temperature can we practically anticipate?

Calculations lead to the conclusion that, as the absolute boiling point under atmospheric pressure is 35°, ebullition under 25 mm. pressure ought to reduce the boiling point some 10° C. For some time experiments have been in progress with the object of determining the temperature of hydrogen boiling under about 25 mm. pressure, but the difficulties encountered have been so great, and repeated failures so exasperating, that a record of the results so far reached becomes advisable. The troubles arise from the conduction of heat by the leads; the small latent heat of hydrogen volume for volume as compared with liquid air; the inefficiency of heat isolation, and the strain on the thermometer brought about by solid air freezing on it and distorting the coil of wire. In many experiments the result has been that all the liquid hydrogen has evaporated before the pressure was reduced to 25 mm., or the thermometer was left imperfectly covered. The apparatus employed will be understood from the figure. The liquid hydrogen collected in the vacuum vessel A was suspended in a larger vessel of the same kind B, which is so constructed that a spiral tube joins the inner and outer test tubes of



which B is made, thereby making an opening into the interior at C. The resistance thermometer D and leads E pass through a rubber cork F, and the exhaustion takes place through C. In this way the cold vapours are drawn over the outside of the hydrogen vacuum vessel, and this helps to isolate the liquid from the connective currents of gas. To effect proper isolation the whole apparatus ought to have been immersed in liquid air under exhaustion. Arrangements of this kind add to the complication, so in the first instance the liquid was used as described. The liquid hydrogen evaporated quietly and steadily under a pressure of about 25 mm. of mercury without the least appearance of solidification or loss of mobility: still remaining clear and colourless to the eye. Naturally the liquid does not last long, so the resistance has to be taken quickly. Just before the reduction of pressure began, the resistance of the thermometer was 0·131 ohm. This result compares favourably with the former observation on the boiling point, which gave a resistance of 0·129 ohm. On reducing the pressure, the resistance diminished to 0·114 ohm, and kept steady for some time. The lowest reading of resistance was 0·112 ohm. This value corresponds to −239·1° C., or only one degree lower than the boiling point at atmospheric pressure, whereas the temperature ought to have been reduced some 10° C., or in any case 5° under the assumed exhaustion.

No blunder having been detected in the observations, for the present we must assume that the platinum resistance thermometer No. 7 acts in the manner described. It would be premature to discuss the inferences to be drawn from these results until they are confirmed on another variety of platinum wire made into a resistance thermometer. But as this will involve the use of considerable quantities of liquid hydrogen, it will take some time to complete the investigation.

The same kind of anomaly appears in the case of the use of a thermo-junction at these low temperatures; but this is a separate matter, and must be dealt with in a further communication.

Linnean Society, December 15, 1898.—Dr. A. Günther, F.R.S., President, in the chair.—On behalf of Captain John Marriott, two crustaceans were exhibited which had been procured by him on a recent journey to the Sinai Peninsula, and had been identified as *Grapsus maculatus* and *Panulirus penicillatus*. A brief account of the distribution and habits was given by Mr. Harting. The Rev. T. R. Stebbing referred to a well-known case of *P. penicillatus* in the Paris Museum, exhibiting the singular monstrosity of an eye-stalk developing a flagellum or lash-like termination, an observation which he thought had not been confirmed. Prof. Howes remarked that the ophthalmite if removed had been proved to regenerate as an antenniform appendage, by Herbst in *Palaemon* ("Archiv. f. Entwickelungsmechanik d. Org.," Bd. ii. p. 544), and by Hofer in *Astacus fluviatilis* ("Verh. Deutsch. Zool. Gesellsch.," 1894, p. 82).—Mr. Thomas Scott communicated a description of some marine and freshwater crustacea from Franz-Josef Land, collected by Mr. W. S. Bruce, of the Jackson-Harmsworth Expedition. The Rev. T. R. Stebbing, who gave the substance of the paper in the absence of the author, considered the collection an important one. The number of species amounted to 173, comprising Macrura 5 species, Schizopoda 2, Cumacea 5, Isopoda 5, Amphipoda 46, Ostracoda 34, Copepoda 66, and Cirripedia 2. Of these 173 species 12 were new.—Mr. H. J. Elwes, F.R.S., gave an account of the zoological and botanical results of a recent journey to the Altai Mountains. The journey commenced practically at Moscow in the middle of May, and extended from the Ural Mountains through Omsk to the River Obi, across a vast and unvarying steppe to Busk, where his natural-history collecting began. After describing the general appearance of the country and the vegetation, Mr. Elwes stated that he had brought home about 180 species of butterflies out of a possible 200 (of which 141 had been collected by himself), and 80 species of moths. As regards plants, finding the flora pretty well known through the labours of Ledebour, Bunge, and Tchihatcheff, he thought it preferable to collect the plants of a small typical valley rather than attempt a general collection made at random. Unfortunately, owing to an accident when crossing a river, the greater part of that collection was lost. He was much struck with the extraordinary beauty and abundance of the alpine plants in certain marshy valleys from 6000 to 7500 feet in altitude. There was a remarkable absence of peat-plants, and hardly any ferns were seen in the Tchuja valley between the Katuna River and the upper Tchuja steppe, a plateau about 6000 feet above the sea, south of which the greater part of the observations were made. From this plateau he journeyed to the high mountains of the south in quest of the famous wild sheep, *Ovis ammon* of Pallas, of which he secured three specimens, which were now exhibited, one having a measurement of 62 inches round the curve of the horn, which is about the largest on record for this species. He mentioned the scarcity of game-birds in the Altai, though *Tetraogallus altaicus* was often seen at an elevation of 8000–9000 feet, accompanying the ibex (*Capra sibirica*) as in the Himalaya and Caucasus. He mentioned the breeding on the mountain lakes of *Oidemia Stejnegeri*, a North Pacific species allied to our velvet scoter. The great stag of the Altai, of which several heads were shown, was evidently an Asiatic form of the wapiti, the antlers having a remarkably long fourth tine, and the peculiar back tine at the top, characteristic of the American animal, and not observable in the European red deer. These were compared with four adult pairs of horns of the Mantchurian *Cervus Luhdorfi*, which had been kindly sent to him by the Duke of Bedford. Though much smaller than either the American or Altai stag, these horns showed the same typical wapiti character, and it appeared as though the races inhabiting the N.W. coast of America and

the N.E. coast-region of Asia more closely resembled each other than they did the other races of their own continent. He exhibited a series of heads of the Siberian roedeer, which were compared with typical heads of the European roedeer, from which it was considered specifically distinct. A discussion followed, in which Mr. J. G. Baker and Dr. O. Stapf criticised at some length the character of the flora of the Altai, Dr. W. T. Blanford and Colonel Godwin-Austen commented upon the mammalia collected by Mr. Elwes, and Sir George Hampson gave some statistics relating to the lepidoptera.

Mathematical Society, January 12.—Prof. Elliott, F.R.S., Vice-President, and subsequently Lieut.-Colonel Cunningham, R.E., Vice-President, and Dr. Hobson, F.R.S., in the chair.—The following papers were read, or communicated in abstract:—Linear transformation by inversions, Dr. G. G. Morrice.—The zeroes of the Bessel functions (No. ii.), by Mr. H. M. Macdonald.—A simple method of factorising large composite numbers of any unknown form, by Mr. Biddle.—On a determinant each of whose elements is the product of k factors, Prof. Metzler.—Properties of hyper-space, in relation to systems of forces, the kinematics of rigid bodies, and Clifford's parallels, Mr. A. N. Whitehead.—On the reduction of a linear substitution to its canonical form, Prof. Burnside, F.R.S.

EDINBURGH.

Royal Society, January 9.—Sir William Turner, Vice-President, in the chair.—Dr. Thomas Muir communicated a paper on the determination of a single term of a determinant.—In a paper on the energy of the Röntgen rays, the Rev. A. Moffat gave an account of some experiments recently made by him in Erlangen. The energy was determined by photometric comparison of the luminescence of the fluorescent screen with a standard candle, and the result was in fair agreement with that obtained by Dorn by a calorimetric method. The discharge was obtained from a Töppler influence machine—a fact which probably explains the shortness of duration of the Röntgen discharge (1/100,000 sec.) as compared with the duration obtained by Trouton, Roito, and other experimenters who used the induction coil.—Dr. R. Broom communicated a paper on the development and morphology of the marsupial shoulder-girdle, which contained an examination of the early stages of development in the common Phalanger, the Ring-tailed Phalanger, and the Rock-Wallaby. Among the conclusions arrived at were the following: (*a*) The well-developed coracoid in the fœtal marsupials, and consequently the coracoid process in the higher mammals, is the homologue of the posterior coracoidal element in the Monotremes and Theromorphs and of the coracoid in reptiles generally. (*b*) The epicoracoid in Monotremes and Theromorphs is the homologue of the precoracoid of the amphibia. (*c*) The only representative of the precoracoid remaining in the higher mammals is the coraco-clavicular ligament.—Prof. Tait, in a note on the hydrokinetic equations, pointed out how the introduction of unit volume of the fluid as a factor of the whole, led to a definite interpretation of each term separately. The interpretation took a curious form in the case of vortex motion.

PARIS.

Academy of Sciences, January 16.—M. van Tieghem in the chair.—The Centenary of the Imperial Military Academy of Medicine of St. Petersburg, by M. d'Arsonval.—On the general course of vegetation, by M. Berthelot. The amount of moisture was determined in different parts of the same plant (*Cynosurus cristatus*), grown in sunlight and in the shade. The plant developed in the shade contains the largest quantity of water.—On the anomalous dispersion of incandescent sodium vapour, and on some consequences of this phenomenon, by M. Henri Becquerel. Incandescent sodium vapour shows an abnormal dispersion for radiations near the lines D_1 and D_2. The index of refraction of the vapour can be clearly shown to be less than unity for radiations of wave-length near to D_1 and D_2. A confirmation is also given of the experiment of M. Voigt, who from theoretical considerations based upon the Zeeman effect concluded that a sodium flame, placed in a magnetic field and traversed by a polarised luminous bundle, ought to show double refraction analogous to a crystallised plate, and in a direction perpendicular to the magnetic field. The phenomenon results from a superposition of the Zeeman effect and abnormal dispersion.—On the treatment of tuberculous abscess, by M. Lannelongue. As an alternative to extirpation, a method of multiple injection is described, the active ingredient in the fluid injected being iodoform.—Results of meteorological observations made in the depression at the centre of Asia (Luktshoun), by M. Alexis de Tillo.—Solar observations made at the Observatory of Lyons, with the Brunner equatorial during the third quarter of 1898, by M. J. Guillaume.—On the variation of density in the interior of the earth, by M. du Ligondès.—On a new slide rule, by M. G. Gallice. This calculating rule is designed for the use of navigators, and by its use problems of nautical astronomy can be rapidly solved.—On the complete integrals of some partial differential equations, by M. N. Saltykow.—Loss of electricity by evaporation of electrified water. Application to atmospheric electricity, by M. H. Pellat. A surface of electrified water, having a surface density slightly greater than that of the earth, loses a portion of its charge on evaporation at the ordinary temperature, but this effect is not sufficient to explain the diurnal variation.—On the transmission of sounds by ultra-violet rays, by M. Dussaud. A modification of the ordinary selenium radiophone, in which ultra-violet rays act upon the selenium cell through a fluorescent substance.—On a physical method of deciding whether dispersion occurs in a vacuum or not, by M. L. Décombe. It is proposed to study the relative velocities of light wave and the electrical oscillations produced by a Hertz exciter.—On the optical properties of the invisible residual luminescence, by M. Gustave Le Bon. Ordinary solar light and the invisible light emitted by phosphorescent bodies possess absolutely identical properties. This residual luminescence completely disappears after a time.—On the source of energy in radio-active bodies, by Sir William Crookes. The suggestion is put forward that uranium and thorium, substances possessing heavy atoms, may have such a structure as to be able to abstract energy from the more rapidly moving air particles, without being affected by the slower air particles: a partial realisation, in fact, of Clerk Maxwell's "demon."—On the peroxidation of cerium dissolved in alkaline carbonates, by M. André Job. Cerium salts dissolved in alkaline carbonates may exist in three states of oxidation, corresponding to Ce_2O_3, CeO_2, and CeO_3.—Triacetylmorphine and the oxidation of morphine, by M. H. Causse. It is shown that a triacetyl-derivative can be obtained from morphine, and that one atom of oxygen is probably present in a ketonic group, CO.—On the ether-chlorides of dibasic acids, by M. E. E. Blaise.—The assimilation of carbohydrates and the elaboration of organic nitrogen in the higher plants, by M. Mazé.—On the Ordovician rocks of Crozon, Finisterre, by M. F. Kerforne.

AMSTERDAM.

Royal Academy of Sciences, December 24, 1898.—Prof. J. A. C. Oudemans in the chair.—Prof. Bakhuis Roozeboom communicated the results of Dr. Van Eyk's inquiries into mixture crystals of KNO_3 and $TlNO_3$. This is the first time that the progress of the solidification and the relation between the composition of a liquid mixture and a solid one has been studied with respect to all concentrations from 0 to 100 per cent. From 0 to 20 per cent. and from 50 to 100 per cent. the mixture crystals, subsiding from the melted substance, contain KNO_3. Between 20 and 50 per cent., a conglomerate of the two limiting mixture crystals is deposited. The transition of all these mixture crystals from the rhombohedrical to the rhombic form has also been studied. This transition is a very complicated process, though it has been found entirely to correspond with the theory lately given by the author. While in the case of $TlNO_3$ the transition takes place at 144°, and in the case of KNO_3 at 129° in the case of mixture crystals it is only completed at 108°. In the rhombic form, too, there is a hiatus in the mixing from 40 to 84 per cent. of KNO_3, which becomes still greater towards a lower temperature.—Prof. Van der Waals made a communication on volume contraction and pressure contraction (ii.), being a continuation of a communication made by himself at the previous meeting, and discussed the course of the magnitude Δ_v. The author demonstrated that even in those cases in which the magnitude was positive, if the mixing took place at low pressure, reversion of the sign was to be expected when the pressure, at which the mixture took place, was very great.—Prof. Kamerlingh Onnes presented (1) a paper by Dr. J. Verschaffelt on determinations concerning the course of the isotherms in the case of a mixture of carbonic acid and hydrogen, in the proximity of the plait point; (2) a paper by Dr. L. H. Siertsema, entitled "Measurements on the magnetic rotatory dispersion of gases." As a continuation of his communications on this subject (*cf. Proc.*, September 1896), the author gives some more details and plates of the apparatus, with a discussion of the results obtained.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 26.

ROYAL SOCIETY, at 4.30.—Contributions to the Theory of Simultaneous Partial Differential Equations: Prof. A. C. Dixon.—On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks. III. On *Medullosa anglica*, a New Representative of the Cycadofilices: Dr. Scott, F.R.S.—On the Nature of Electro-Capillary Phenomena. I. Their Relation to the Potential Differences between Solutions: S. W. J. Smith.

ROYAL INSTITUTION, at 3.—Tibet and the Tibetans: A. Henry Savage Landor.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains: J. Pigg.—The Regulation of Wiring Rules: C. H. Wordingham.—The Institution Wiring Rules: R. E. Crompton.

FRIDAY, JANUARY 27.

ROYAL GEOGRAPHICAL SOCIETY, at 4.—The Sub-Oceanic Physical Features off the Coast of Western Europe, including France, Spain, and Portugal: Prof. Edward Hull, F.R.S.

PHYSICAL SOCIETY, at 5.—On the Equivalent Resistance and Inductance of a Wire to an Oscillatory Discharge: Dr. Edwin H. Barton.—Exhibition of (*a*) a Dephlegmator; (*b*) a Temperature Tell-Tale: R. Appleyard.—On the Volume Changes accompanying Solution: T. H. Littlewood.

INSTITUTION OF CIVIL ENGINEERS, at 8.—King's Lynn Water Works: F. C. Grimley.

SATURDAY, JANUARY 28.

ESSEX FIELD CLUB (Technical Institute, Stratford), at 6.30.—Exhibition of Geological Photographs (Lantern) brought together by the British Association Committee: T. V. Holmes.

MONDAY, JANUARY 30.

SOCIETY OF ARTS, at 8.—Bacterial Purification of Sewage: Dr. Samuel Rideal.

IMPERIAL INSTITUTE, at 8.30.—West Africa: Miss M. H. Kingsley.

TUESDAY, JANUARY 31.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

SOCIETY OF ARTS, at 4.30.—The Centenary Exhibition of Lithographs, with Remarks on Further Developments of the Art: Edward F. Strange.

ROYAL MINERALOGICAL SOCIETY, at 8.—Experiments with Zeolites: Prof. A. H. Church, F.R.S.—Analyses of Ceylon Apatite: by the same.—On a New Mode of Occurrence of Ruby in North Carolina: Prof. J. W. Judd, C.B., F.R.S., and W. E. Hidden; with Crystallographic Notes by Dr. J. H. Pratt.—On the Constitution of the Mineral Arsenates and Phosphates. II. Pharmacosiderite: E. G. J. Hartley.—On the Chemical Composition of Binnite: G. T. Prior and L. J. Spencer.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Papers to be further discussed: The Effects of Wear upon Steel Rails: William G. Kirkaldy.—On the Microphotography of Steel Rails: Prof. Roberts-Austen, K.C.B., F.R.S.—And, time permitting: The Waterworks of the Madras Presidency: J. A. Jones.

WEDNESDAY, FEBRUARY 1.

SOCIETY OF ARTS, at 8.—The Cost of Municipal Enterprise: Dixon H. Davies.

GEOLOGICAL SOCIETY, at 8.—On Radiolaria in Chert from Chypon's Farm, Mullion District, Cornwall: Dr. G. J. Hinde, F.R.S.—Gravel at Moreton-in-the-Marsh (Gloucestershire): S. S. Buckman.—On the Occurrence of Pebbles of Schorl-Rock from the South-West of England in the Drift Deposits of Southern and Eastern England: A. E. Salter.

THURSDAY, FEBRUARY 2.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Sets of Operations in relation to Groups of Finite Order: A. N. Whitehead.—Note on the Enhanced Lines in the Spectrum of α Cygni: Sir J. Norman Lockyer, F.R.S.—On the Effects of Strain on the Thermo-Electric Qualities of Metals: Dr. Magnus Maclean.—The Constitution of the Electric Spark: Prof. A. Schuster, F.R.S., and G. Hemsalech.

ROYAL INSTITUTION, at 3.—Tibet and the Tibetans: A. H. Savage Landor.

LINNEAN SOCIETY, at 8.—Notes on the Genus Nanomitrium, Lindberg: E. Stanley Salmon.—On the Production of Apospory by Environment in *Athyrium filix-foemina*, var. *unco-glomeratum*, an apparently Barren Fern: Dr. F. W. Stansfield.—On the Genus Lemnalia, Gray, with an Account of the Branching System of the Order Alcyonacea: Gilbert C. Bourne.

CHEMICAL SOCIETY, at 8.—(1) Maltodextrin, its Oxidation Products and Constitution: (2) On Attempts to prepare Pure Starch Derivatives through their Nitrates: Dr. H. T. Brown, F.R.S., and J. H. Millar.—An Isomeride of Amarine: Dr. H. Lloyd Snape and Dr. Arthur Brooke. Propylbenzenesulphonic Acids: Dr. G. T. Moody.—Derivatives of Dibenzylmesitylene: W. H. Mills and T. H. Easterfield.—On the Action of Chlorosulphonic Acid on the Paraffins and other Hydrocarbons: Dr. Sydney Young, F.R.S.—(1) The Action of Reducing Agents on Nitrogen Iodide; (2) The Action of Acids upon Nitrogen Iodide: F. D. Chattaway and H. P. Stevens.—The Composition of Nitrogen Iodide: F. D. Chattaway. (1) The Preparation and Properties of Nitrogen Iodide; (2) The Action of Light upon Nitrogen Iodide; (3) The Action of Alkaline Hydrates, of Water, and of Hydrogen Peroxide upon Nitrogen Iodide; (4) Theory of the Formation and Reactions of Nitrogen Iodide: F. D. Chattaway and Kennedy J. P. Orton.

FRIDAY, FEBRUARY 3.

ROYAL INSTITUTION, at 9.—The Roman Defences of South-East Britain: Prof. Victor Horsley, F.R.S.

GEOLOGISTS' ASSOCIATION, at 7.30.—Annual Meeting.—Address by the President, J. J. H. Teall, F.R.S.

QUEKETT MICROSCOPICAL CLUB, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Sketch of the Evolution of our Native Fruits: L. H. Bailey (Macmillan).—Handbook of Metallurgy: Dr. C. Schnabel, translated by Prof. H. Louis, 2 Vols. (Macmillan).—Traité de Zoologie Concrète: Y. Delage and E. Hérouard, Tome viii. (Paris, Schleicher).—Among the Himalaya: Major L. A. Waddell (Constable).—Untersuchungen über Strukturen: Prof. O. Bütschli, Text and Atlas (Leipzig, Engelmann).—Dictionnaire Technique: H. S. Lovendal (Paris, Boyveau).—Ostwald's Klassiker der Exakten Wissenschaften, Nr. 101 and 102 (Leipzig, Engelmann).—A Short History of Astronomy: A. Berry (Murray).—River Development: Prof. I. C. Russell (Murray).—The Temple of Mut in Asher: M. Benson and J. Gourlay (Murray).—Zoological Results: Dr. A. Willey, Part 2 (Cambridge University Press).—A Treatise on Photographic Optics: R. S. Cole (Low).—The Native Tribes of Central Australia: Prof. B. Spencer and F. J. Gillen (Macmillan).—The Book of the Master: W. M. Adams (Murray).—An Intermediate Text Book of Geology: Prof. C. Lapworth, new edition (Blackwood).—Photo-micrography: E. J. Spitta (Scientific Press).—Gordon in Central Africa: edited by Dr. G. B. Hill, new edition (Macmillan).—Fertilizers: Prof. E. B. Voorhees (Macmillan).—Mathematical Tables, Wrapson and Gee (Macmillan).—The Marine Steam-Engine: C. Busley, translated by H. A. B. Cole, 3rd edition, 2nd Part (Grevel).—Annuaire de l'Observatoire Royal de Belgique, 1899; and ditto, Supplément to 1898 (Bruxelles).—A Class-Book of Physical Geography: Prof. W. Hughes: Revised, &c., by R. A. Gregory (Philip).—Pubblicazioni della Specola Vaticana, Vol. v. (Roma).—An Introduction to the Mathematical Theory of Attraction: Prof. F. A. Tarleton (Longmans).—The Testing of Materials of Construction: Prof. W. C. Unwin, 2nd edition (Longmans).—Creation Myths of Primitive America: J. Curtin (Williams).—Outlines of Industrial Chemistry: Dr. F. H. Thorp (Macmillan).

PAMPHLETS.—The World's Exchanges in 1898: J. H. Norman (Low).—A Course of Lectures on Mining: Prof. W. Galloway; Colliery Explosions (Cardiff).—"Representative Indians" in Court, or What is Authorship?: Sastri and Pillai (Madras).

SERIALS.—Natural Science, January (Pentland).—Himmel und Erde, January (Berlin).—An Illustrated Manual of British Birds: H. Saunders, 2nd edition, Parts 13 to 15 (Gurney).—American Journal of Science, January (New Haven).—Beiträge zur Biologie der Pflanzen, viii. Band, 1 Heft (Breslau).—Transactions of the English Arboricultural Society, Vol. iv. Part 1 (Carlisle).—Educational Review, January (203 Strand).

CONTENTS.

THURSDAY, FEBRUARY 2, 1899.

THE RECORDS OF THE ROCKS.

The Principles of Stratigraphical Geology. By J. E. Marr, M.A., F.R.S. Pp. 304. (Cambridge: University Press, 1898.)

GEOLOGY is admittedly a complex science, and Mr. Marr, no doubt rightly, speaks of it as one of the uncertain sciences. It is well for the student to be able clearly to discriminate between that which is ascertained and that which is inferred: and even individual knowledge may be dangerous when the limits of it are not clearly realised. The task of the stratigraphical geologist is, as the author points out, to establish the order of succession of the strata and to ascertain the conditions which existed during their deposition.

Possessed of a good general knowledge of the elements of geology and palæontology, the enthusiastic student will desire to engage in original observations in the field, and in the absence of the Cambridge University Lecturer in Geology, he will do well to carry this book with him. The chapter on the growth and progress of stratigraphical geology shows how much was accomplished in early days by traverses and sketch-maps, how the broad outlines were to some extent filled in on one-inch maps by subsequent observers, and how necessary it is nowadays to labour in greater detail and express the results of field-work on maps on the scale of six inches or even twenty-five inches to a mile. Experience in geological surveying is the best basis for further work—the student will then understand the structure of the ground, the local sequence of the strata and the nature of their organic remains. Even in geological mapping the uncertainties of the science, which Mr. Marr takes care to point out, are nowhere absent.

In considering the terms applied to sedimentary rocks, and the varying nature of the rocks themselves, we may feel that there is a want of precision in our language and in our geological boundary-lines; but the geologist soon learns that harmony and order are everywhere apparent amid the gradual changes of scene and life and climate which the strata reveal, and that their continuity is only locally interrupted. With regard to uniformitarianism the author rightly maintains that it is unphilosophical to hold that the agents which are in operation to-day are similar both in kind and intensity to those which were at work in past times. At the best our information is too incomplete to allow of dogmatism; and the student should be prepared "to consider that the more active operation of agents, even in times of which he has definite knowledge, may have produced effects which he should be prepared to discover."

Every year the labours of the student become more detailed. From the broad groupings of the old masters we have now to consider minute subdivisions in the strata, and the palæontological stages or zones which mark the succession of life. These detailed studies are all important when we seek to make out the chronology of the earth in general, but there is no doubt that much of the minute work in connection with the succession and evolution of species is more of a biological than a geological study. The geologist is mainly concerned with the natural history of successive periods, with the character of the formations, the conditions and climate which they indicate, and the movements to which they have been subjected.

In perusing this volume the student will find many a useful hint with regard to the superposition of strata, the effects of folds and faults, the included organisms whether original or derived, and the simulation of structures organic and inorganic. In considering the somewhat vexed subject of contemporaneity, the author is careful to point out that when we find the same fauna in different localities it is justifiably assumed that the species did not originate simultaneously in the two areas. Nevertheless, "everything depends on the time taken for migration as compared with the period of existence of the fauna." Thus we may "speak of the strata as contemporaneous, just as an historian would rightly speak of events in the same way which occurred upon the same afternoon, though one might have happened an hour before the other." The student will do well to bear in mind these remarks, for a few hours in our lives may be as a hundred, or even a thousand, years in the life-history of a zone.

Again, in reference to the recurrence of species, Mr. Marr observes that instances are by no means rare, but "that the whole fauna does not disappear for a time and then reappear, but only a few out of the many forms which compose it." Some remarks are naturally made on homotaxis, and to Huxley's assertion that a Devonian fauna and flora in the British Islands may have been contemporaneous with Silurian life in North America and with a Carboniferous fauna and flora in Africa. Subsequent researches have in no degree lent support to this notion, and we may be content to speak of practical contemporaneity without implying that absolute synchronism which it would be impossible to establish in comparing formations far apart. It is curious to note on p. 19, that Mr. Marr speaks of the Devonian system being finally placed "upon a secure basis," while on p. 184 he admits that the Devonian question is not settled. The fact is that the characteristic Middle Devonian fauna is distinct, but we do not yet know to what extent the Lower and Upper Devonian strata in this country include horizons elsewhere grouped as Silurian or Carboniferous.

After giving some account of the conditions under which strata are formed, the author reviews generally the successive stratified formations, both in this country and abroad, without entering into much detail. With regard to terms, we would not say that "Primary has been definitely abandoned." It is used by Sir A. Geikie in his "Text-book of Geology," by Prestwich in his "Geology," vol. ii., and by Lapworth in his "Intermediate Text-book of Geology" (1899). The term Permo-Carboniferous is useful as a temporary name for a group to which much attention is being given; but we would rather use Holocene than "The Forest Period" for the deposits often spoken of as Recent, and which succeed the Pleistocene. We have said enough, however, to indicate that the work will prove exceedingly useful to the

advanced student; it is full of hints and references, gathered during the author's long experience as a teacher and observer, and which will be valuable to all who seek to interpret the history of our stratified formations.

H. B. W.

THE MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM.

A Treatise on Magnetism and Electricity. By Andrew Gray, LL.D., F.R.S. In 2 Vols. Vol. I. Pp. xv + 479. (London: Macmillan and Co., Ltd., 1898.)

IN the preface to this book Prof. Gray defines his aim to be the presentation of the whole subject of electricity and magnetism from the point of view of action in a medium, and his method to be a preliminary consideration of the phenomena, followed by a development of the consequences of assuming that the medium is a receptacle of energy according to certain laws, and a proof that among these consequences the observed phenomena are included. At the same time, it is proposed that the work should not deal with theory alone, but should take account of its applications to questions of practical interest.

In following out the first part of this scheme the author commences with magnetism, reviewing the elementary facts, and showing how they are related to the condition of the media occupying the field. Then, as applications, come chapters on terrestrial magnetism and on the deviations of the compass in an iron ship. Next, the elementary facts of electrostatics and the theory of this part of the subjec are dealt with in a similar manner; they are followed by a treatment by the ordinary mathematical methods of a number of electrostatical problems and of the steady flow of electricity in systems of linear conductors.

At this point, in order to provide suitable mathematical equipment for the student of electromagnetism, two chapters are interpolated: one on general dynamical theory, in which Lagrange's and Hamilton's equations are explained; and one on hydrodynamics, which extends to the consideration of vortex motion.

The experimental results relating to mechanical actions between magnets and currents are next described, and their theory worked out; then, after a short account of the fundamental experiments on electromagnetic induction, the application of general dynamical principles to the treatment of a system of circuits is explained, and some problems on circuits with capacity and inductance are solved. A chapter on general electromagnetic theory follows, touching upon electromagnetic waves, the transference of energy in an electromagnetic field, and the behaviour of moving electric charges, with a short account of the Zeeman effect. Part of the subject of contact electricity next receives treatment, and the volume concludes with a short chapter on thermo-electricity.

It is the misfortune of an author with the reputation of Prof. Gray that general commendation must pass him by. To hint at his authority as a teacher, or to insist on the industry, learning and research displayed in his books, is wholly unnecessary; and, at the risk of appearing ungracious, it may be of more utility to bring forward objections, and to reveal blemishes for consideration and removal in a subsequent edition.

First of all, then, it is possible that after vol. ii. is written the author, having quarried the whole of his material, may find himself able to improve its general arrangement in some respects. In particular, we would plead for an early treatment of the phenomena of magnetisation in iron and steel, which surely is more germane to the plan of this treatise than the precedence given to terrestrial magnetism and ships' magnetism, for rearrangement and further elucidation in the domain of general electromagnetic theory, and for the postponement of contact electricity until it can receive fuller discussion in connection with electro-chemical phenomena and theories.

Secondly, as the book is clearly intended for the use of students, it may be urged in their interest that, whenever it is necessary to state a result which cannot be deduced from what precedes it, great assistance would be given by drawing attention to the fact. For example, the conscientious student will be discouraged by his failure to obtain the expression given at the end of § 498, and there is no hint that it must either be accepted as an article of faith, or traced to Prof. J. J. Thomson's "Recent Researches." Again, when he reaches the beginning of § 500, and reads concerning a perfectly conducting wire that "there would be no dissipation in it, but energy would enter it," he has not been supplied with the knowledge which would enable him to insert before "energy" the word "no," which has been omitted by the printer. Also, he may well be pardoned for complaining that the next sentence but one is a very hard saying indeed.

A few inaccuracies may also be pointed out. The numerical example on the torsion balance (§ 16) would present a difficulty to any one, if such a man there be, who is not familiar with problems on this instrument, and the difficulty would be intensified by the remark (§ 17) that "no account was taken of the earth's field in determining the forces acting on the magnet." In the description of Maxwell's dynamical model illustrating the induction of currents (§ 451), the long bar is wrongly stated to be rigidly attached to the axle of one of the wheels, when it is, in fact, free to rotate about this axis; but the analysis, which follows, exposes the oversight. A more serious error occurs in § 232, which states, and sets out to prove, that the actual distribution of currents in a net-work of conductors containing internal electromotive forces corresponds to a minimum rate of production of heat, *i.e.* that with the usual notation, $\Sigma(RC^2)$ is a minimum. The conclusion reached, however, is that $\Sigma(RC^2 - EC)$ has a minimum value which is zero, a plausible result, but due to an algebraical lapse, by which a term is omitted in the final equation. If this is corrected we obtain the true law, namely, that $\Sigma(RC^2 - 2EC)$ is a minimum, which is demonstrated in a foot-note to the third edition of Maxwell's "Electricity" (vol. i. p. 408).

These suggestions are put forward in no spirit of disrespect towards an author who has earned the gratitude of so many students of electrical science, but with the conviction that, in the case of a text-book, absence of errors is as great a recommendation as excellence of a less negative character.

L. R. W.

YOUNG'S GENERAL ASTRONOMY.

A Text-book of General Astronomy. By Charles A. Young. Revised edition. Pp. ix + 630. (London: Ginn and Co., 1898.)

EVERY student of astronomy is familiar with this well-known text-book, and it is not too much to say that it is as well used this side of the Atlantic as it is on the other. Written for a general course in colleges and schools, and meant to supply that amount of information upon the subject which may fairly be expected of "every liberally educated person," it is only natural that too great an attention to details must give way to more general statements. Since the first publication of this volume, now nearly ten years ago, astronomical science has made rapid changes and advances, and the time necessarily comes when minor alterations, notes, and addenda, &c., in subsequent editions of a text-book like this cannot be satisfactorily inserted without considerable difficulty, and probably detriment to the book itself. Prof. Young has therefore thoroughly revised his text-book, and it is this new edition that we have now before us. A glance through the pages of this book, with an occasional reference to the older volume, displays many differences and additions of new matter. In Chapter ix., for instance, we notice that the illustration of the tele-spectroscope has been replaced by a nearly full-page plate of the large grating spectroscope of the Halstead Observatory. In another paragraph, describing a sun-spot spectrum, an excellent reproduction of a photograph of the yellow-green portion of a spot spectrum is added, giving the reader a good idea of the meaning of widened lines in sun-spot spectra. Prof. Young refers in another paragraph to the so-called "reversing layer," describing the phenomenon as he saw it in the Spanish eclipse of 1870. The only additional matter here added is a brief note, in which it is stated that the photograph of the chromosphere taken in Novaya Zemlya in 1896 "fully confirms the author's visual observations, and appears to establish the reality of the 'reversing layer.'" We may mention that photographs taken at Viziadrug in 1898 were more numerous and on a far larger scale than any obtained previously, and have yielded very important results on this very question. Photographs of the so-called "reversing layer" were obtained on several plates successively exposed during twelve seconds, and a comparison of the chromosphere with the solar spectrum shows many important differences. In fact, to use Sir Norman Lockyer's own words (NATURE, No. 1515, vol. lix.)—

". . . practically the lower part of the sun's atmosphere, if present by itself, would give us the lines which specialise the spectra of γ Cygni or Procyon. I recognise in this result a veritable Rosetta stone which will enable us to read the celestial hieroglyphics presented to us in stellar spectra, and help us to study the spectra and to get at results much more distinctly and certainly than ever before."

In that part of the same chapter in which the photography of prominences and chromosphere is discussed, Prof. Young mentions that both Hale and Deslandres have devised ingenious arrangements (called *spectroheliographs*) by which they are able "to obtain pictures of the chromosphere and prominences around the whole circumference of the sun at once." Although the text has been carefully perused, the author does not seem to have made it sufficiently clear that besides the phenomena *around* the circumference, those *on* the solar disc can be photographed by the same means.

In the chapter devoted to the planets and their motions we find that a thorough revision has taken place, and more especially in respect to the recent values of their elements. Prof. Keeler's beautiful confirmation of the meteoric theory of the satellites of Saturn by means of the spectroscope is clearly described and illustrated.

Lastly, it is interesting to note that in Prof. Young's opinion the meteoritic hypothesis is gaining ground, for to use his own words—

"While it would be premature to endorse this speculation of Mr. Lockyer's as an established discovery (since there remain in it many obscure and doubtful points), there can be little doubt that it marks an epoch in the history of opinion."

Before bringing this notice to a conclusion it may be stated that the present volume will continue to hold its high position among text-books on this side of the Atlantic. The same standard of clearness of exposition has been maintained throughout, and the illustrations are all to the point. Misprints are very few and far between, and only one has been discovered in our examination, namely, that on p. 536, line 11 from top, where "filled" is printed for "fitted."

W. J. S. L.

OUR BOOK SHELF.

The Campaign in the Tirah. By Colonel H. D. Hutchinson. Pp. xvi + 250. (London: Macmillan and Co., Ltd., 1898.)

THE "Campaign in the Tirah" is for the most part a reprint of the letters which appeared in the *Times* during the progress of that expedition, which were written by the author of the present book, and which must be fresh in the minds of the reading public. But Colonel Hutchinson has added to them an introduction in which he deals with the probable causes of the general outbreak on the north-west of India, and an appendix in which he sums up the lessons to be learnt from the campaign, and points the military moral of the whole story. Both these additions are valuable. From the point of vantage of his official position as Director General of military education in India, Colonel Hutchinson has been able to watch the development of those issues of our frontier policy which have been discussed so freely in England, with more discrimination, and with a more unbiassed mind, than falls to the lot of many public officials who are committed to the support of Government policy. And he is, at the same time, best qualified to gather instructive morals from the object-lessons of the campaign.

In the introduction we have a very clear expression of opinion as to the meaning of the outbreak, and the origin of it; and we shall probably not be far wrong if we assume that this opinion tallies closely with that of every frontier official who is in direct touch with Pathan communities, or who is conversant with the views of educated Mahomedan gentlemen in the Punjab. Colonel Hutchinson traces the universal uprising of the Pathan tribes along the whole line of the frontier to the natural fear of losing their independence, which was roused by the process of

demarcating the "Durand" boundary. It commenced with the commencement of demarcation at Wana; it continued *pari passu* with the process at Chitral; and it ended only when the proposal to divide the Mohmand country in half by an outward and visible boundary line was abandoned.

"And how can we blame these people, simple, savage and unsophisticated as they are? We may explain to them as much as we like, and protest as loudly as we can, but when they see the long line of boundary pillars going up; when they are told that henceforth all inside that line practically belongs to the British *Raj;* and that from this time their allegiance must be to us; and when, finally, they note our surveyors at work, mapping their country, and measuring their fields, their reflection is, 'Methinks you do protest too much!' And they are irresistibly driven to the conclusion that their country is annexed and their independence gone."

It is, indeed, hardly necessary to assume that the Pathan is either "simple" or "unsophisticated" to account for his arrival at this conclusion.

The story of the campaign is well told, and the illustrations, although here and there they betray the sketchiness of the amateur, are on the whole exceedingly effective.

Preliminary Report of an Investigation of Rivers and Deep Ground Waters of Ohio as Sources of Water Supplies. By the State Board of Health. Pp. 259. (Cleveland: J. B. Savage Press, 1898.)

BY an Act of the Legislature of the State of Ohio, U.S.A., it is provided that no city, village, or corporation shall introduce a public water supply, or system of sewerage; or change or extend any public water supply or outlet of any sewage unless the proposed works shall have been submitted to, and received the approval of, the State Board of Health; and by a subsequent Act it was ordered that the Board of Health should examine and report annually on the condition of all public water supplies. The enactment of these laws grew out of the general recognition of the fact that the pollution of streams and lakes by sewage had already reached a point when it had become a menace to public health, and that some intelligent supervision and control of the sources of public water supply had become necessary.

The Board of Health, in order to be in a position to deal in a comprehensive manner with the various schemes submitted for approval, has commenced an investigation of all the sources of supply and of the streams and rivers of the State; maps and statistics have been prepared, showing the principal towns and villages and the sources of water supply and sewage disposal; and a laboratory has been established for chemical and bacteriological examination. The report now issued deals in a very complete and comprehensive manner with the way in which the investigations of the Board are carried out; the methods of analysis, the results of bacteriological examination, reports on gauging, and the merits of different geological formations as sources for water supply. Although confined to the water supply of Ohio, the information given cannot but be of great interest and value to sanitary engineers and chemists engaged in works of a similar character in this country.

The Periodical Cicada. By C. L. Marlatt, First Assistant Entomologist. *Bulletin*, No. 14, New Series. Department of Agriculture, Division of Entomology. (Washington, 1898.)

WE learn from Dr. L. O. Howard's "Letter of Transmissal," prefixed to this Report, that it is intended to replace a former *Bulletin* on the same subject published in 1885. He says that the insect is "distinctly American, and has the longest life period of any known insect. Economically, it is chiefly important in the adult stage from the likelihood of its injuring nursery stock and young fruit trees by depositing its eggs." We are inclined, however, to think that several large wood-feeding insects, such as Longicornes and *Siricidae*, sometimes surpass the *Cicadae* in the length of their life; and one or two *Lepidoptera*, such as *Eriogaster lanestris*, may remain in the pupa state for many years. Among the peculiarities of this *Cicada* are the periodicity of its broods, some appearing at intervals of seventeen years (whence its name), and others at intervals of thirteen years; and the dimorphism of the insect, which constantly exhibits a large form and a small form side by side in the same brood. This periodicity renders it easy to calculate when it will be common in any special locality, according to the number of thirteen-year or seventeen-year broods which may be running their course parallel with each other. Owing to the destruction of forests, however, it is much less abundant than formerly, and is hardly to be reckoned now with really destructive insects. The English sparrow, too, destroys great numbers. W. F. K.

The Brain-Machine: its Power and Weakness. By Albert Wilson, M.D. Pp. vi + 157 + 24 Plates. (London: J. and A. Churchill, 1899.)

MUCH instructive information concerning the structure and mechanism of the brain and nervous system, and the mechanism of thought and mind, is presented in a popular style in this volume. The aim of the author appears to be to show how to preserve the health and integrity of the brain-cell, and to point out the importance of the subject in national as well as individual welfare. The volume should be of assistance to parents and schoolmasters who are concerned with the education of children, for while the author pleads for the cultivation of brain-power, he shows that the *mens sana* requires to be *in corpore sano.*

The Swastika. By Thomas Wilson. Pp. 255. (London: W. Wesley and Son, 1898.)

THIS interesting monograph on the Swastika, prepared by Mr. T. Wilson, Curator of the Department of Prehistoric Anthropology, United States National Museum, appeared in the report of the Museum for 1894, and has already been described in these columns. The Swastika is the earliest known symbol, and the object of Mr. Wilson's memoir is to trace its migrations. The volume contains 374 figures in the text, and 25 plates, including a chart of the geographical distribution of the symbol. Many students of archæology will be interested in the contents.

Dictionnaire Technique Français-Anglais. By A. S. Lovendal. Pp. viii + 158. (Paris: Boyveau et Chevillet, 1899.)

THE French and English equivalents of the names of tools used in various trades are shown in parallel columns in this volume. We have, for instance, the phrase "Étau à tige à mâchoire étroite" as the equivalent of dog-nosed tail vice, and the phrase "Compas double calibre à ¼ de cercle entaille" as the equivalent of egg callipers with groove wing. The volume will be of service to technical students both in France and England, and it will serve to warn translators against the literal rendering of expressions with which they are not familiar.

Incubators and Chicken Rearing Appliances. Pp. vi + 64. (London: Cassell and Co., Ltd., 1898.)

THE chapters on the construction and use of incubators, contained in this pamphlet, originally appeared in the periodical *Work.* They are essentially practical, and may furnish keepers of poultry with useful hints. The references to the natural *heat* of a hen's body as 98° F., and the *heat* at which to work, will be understood by the readers of the pamphlet, but it would have been better to have used the word temperature instead of heat.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Prof. Meldola and Mr. Herbert Spencer as Critics.

THREE letters have lately appeared in these columns commenting on my book lately published under the title of "Organic Evolution Cross-examined." Two of these are by Prof. Meldola, and one by Mr. Herbert Spencer. By the first I ought to feel much honoured, because the Professor lays down the law that nobody outside the class to which he himself belongs, namely professional experts, should be allowed to write or be listened to on such subjects as biology. One feels the atmosphere of condescension throughout his ostensible criticism, and he thinks it necessary to excuse himself for taking so much trouble as to criticise it at all. Perhaps he will allow me to explain what my doctrine and practice about experts has always been. It has been to take them frankly for all that they are worth, and that is much. First, I always accept everything they can tell us on matters of fact. Secondly, I always examine closely the language or phrases under which those facts are expressed, to see how far silent assumptions, or artificial conceptions, are imported into the interpretations of the facts of nature. Thirdly, I watch to see how far they set up an artificial vocabulary of their own, having for its object to wipe out of all natural phenomena the highest intellectual conceptions to which they are related. I am sorry to say that I do not know enough of Prof. Meldola's writings to be able to say how they would be found to stand this weapon of analysis. But I am struck by the fact that he seems to attribute to me the application of the word "plan" to organic structures: thus showing, on the one hand, great antipathy to the word; and, on the other hand, complete ignorance or forgetfulness that the word, in that sense, is not mine, but the word systematically used by Prof. Huxley in all his most typical works. This makes me suspect that Prof. Meldola may yield to the very common temptation to manipulate language so as to keep out of sight suggestions of thought which are instinctive but which are dangerous to his own theories and philosophy. I note, also, that in his condescending criticism of my book he deals a good deal in chaff; and when he encounters a fact or an argument not easily dealt with, he rides off in some flippant joke, as in the case of the electric organs of the torpedo and other fishes. Considering that Dr. Romanes thought my argument on those organs so strong, that if there were many other cases in nature of the same kind, he would be obliged to give up the Darwinian theory, it is surely worth the trouble even of so great an expert as Prof. Meldola to give some serious reply.

But I pass from Prof. Meldola to a criticism which concerns me a great deal more—because it comes from Mr. Herbert Spencer, for whose intellectual integrity I have the highest admiration and respect.

In my book I have dwelt at some length on the sad fate which has befallen both the celebrated phrases in which the Darwinian theory has been clothed. I have represented both of them as having come to grief, and as having been exposed to a most destructive criticism at the hands of no less an authority than Mr. Herbert Spencer, himself the author of one of these phrases, and one of the earliest patrons of the other. In this Mr. Spencer thinks I have been unfair to him. Let us hear, then, what he says in explanation.

As regards the phrase "natural selection," Mr. Spencer says that he pointed out that "its metaphorical character is apt to mislead." Exactly so! But how? It is all metaphor together. "Selection" is the idea on which it turns, and in the Darwinian theory there is no selector. But its whole popularity, and the whole possibility of the phrase representing the facts of biological science depended on the analogy of a breeder; and when this element of meaning was abandoned and denounced, nothing remained behind. Men may choose to go on using it, if they like, but as the expression of a systematic theory it is gone.

Well, now, what has Mr. Spencer done with the alternative phrase invented by himself? He says that "kindred objections may be urged against 'survival of the fittest,'" for just as selection suggested a human selector, so did the word "fittest" suggest some fitter. Therefore both phrases were alike metaphors, and both were therefore equally deceptive. There is no fitting, he says, in nature like that of a glove to a hand, or of a key to a lock. I deny this absolutely. But assuming it to be so, then the word should be given up as applied to the marvellous adaptations of structure to functions in organic life. The whole virtue of the phrase is gone. I have not meant to allege that Mr. Spencer himself sees the full effect of his destructive criticism, or that he may not continue to hold by the child of his earlier years for some purposes of literary convenience. But we—the public and the scientific world—have nothing to do with that. What we have a right to deal with is a phrase which has enjoyed a wide popularity, and which has purported to express and to explain correctly the course of development in organic life. We find the author of this phrase admitting that it has in it elements lending themselves to deception, and that it suggests correlations of a kind which have no place in nature. This is to me an abandonment of the phrase, whether the original author of it thinks it so or not. The phrase is no longer his exclusive property. It belongs to the history of philosophy, and the criticisms of its own orginator are among the most valuable helps we have in estimating any value it ever had. Mr. Spencer has now invented another phrase—"the theory of indirect equilibration"—which he represents as equivalent, and with reference to which I venture to predict that it will speedily share the fate of both its predecessors, as only one more attempt to hide out of sight, under the cover of a new and grotesque vocabulary, some of the most salient facts of biological science.

ARGYLL.

IGNORING all personalities, expressed or implied, in the above communication, there are a few points which call for rejoinder. In the first place, the statement that I have laid down the law that none but professional experts should be allowed to write on biological subjects is a complete misrepresentation of my views. I have on more than one occasion made statements in precisely the opposite sense. If I may be permitted to quote from an address to the Entomological Society of London in 1896 (reprinted in these columns), I will invite the Duke of Argyll's attention to the following passage:—"As far as my reading extends, I am inclined to believe that even in the case of the purely literary treatment of biological problems by writers who are not experts, the danger of overweighting the science with hypothesis is much exaggerated. Writers of this class are often capable of taking a wider and more philosophic grasp of a problem than a pure specialist, and ideas of lasting value have sometimes emanated from such sources. I imagine that nobody will dispute that Mr. Herbert Spencer's writings have largely influenced the public mind—whether we agree with the details of his doctrines or not—in accepting the broad principle of Evolution, although this profound thinker lays no claim to an expert knowledge of any branch of natural history. But every working naturalist can ascertain for himself the credentials of any particular writer: my remarks are simply offered with the object of claiming more consideration for such writers, as a class, on the part of practical workers. The philosophic faculty is quite as powerful an agent in the advancement of science as the gift of acquiring new knowledge by observation and experiment. It is not often that the faculties are combined in one individual."

In the next place, it is a misrepresentation to credit me with an antipathy to the word "plan." I have not the least objection to the word or to the idea which it conveys, but I do protest most emphatically against its being introduced by way of an explanation into any branch of science, biological or otherwise. The attempt to make Huxley responsible for the use of the term in this sense is, as I have already pointed out, a misrepresentation of that writer's views.

The paternal insight into the affairs of nature which leads a non-expert writer to put himself into the position of a judge of the value of experts must be a source of immense admiration to the working body of naturalists. I have nowhere laid claim to the distinction of being classed among that body, as my working days in that field are, I am afraid, closed. Nevertheless, I feel duly honoured at the Duke of Argyll's classification of myself with the "experts." Any obscurity under which I may be suffering in the scientific world through the neglect of his Grace to put my writings through his analytical process is, however, relieved—at any rate temporarily—by the invitation of the editor of NATURE to review the book which has given rise to this correspondence. In performing that duty in what I conceive to be the best interest of science, I have preferred to encounter the Duke's views in the open, rather

than under the cover of anonymity. His Grace will, I trust, extend to me at least a small measure of "intellectual integrity" on that score. If the "experts" are to be weighed and measured by some standard of the Duke's creation, then it is obvious that this body of gleaners might reasonably express some kind of opinion as to the value of the treatment to which their facts are being submitted. I have already endeavoured to put forward a plea on behalf of the non-expert philosophical writer, and I have expressly said that naturalists will ascertain for themselves the credentials of each writer. The Duke's contributions have for many years been of a purely destructive order; how far the credentials of a writer who has contributed so little constructively to the edifice of biological science will carry weight with the body of working naturalists is for them to declare.

A few words in conclusion as regards the electric organs of the torpedo. I am the last person to ignore the difficulties in the way of the theory of natural selection. Perhaps I have more faith than my late lamented friend Dr. Romanes in the power of a theory which explains so much being able, when we know more about them, to meet such cases as these; but this is a purely personal matter. The particular difficulty in question, like most others of weight, was long ago suggested to Darwin himself, and was discussed in the "Origin of Species" (6th ed., p. 150). It was discussed also in a letter to Lyell in 1860 ("Life and Letters," vol. ii. p. 352). But if the whole theory of natural selection were to break down on such a difficulty, the doctrine of a "preconceived plan" would not help us in the least. It would not be a philosophical explanation, but, with the very greatest deference to my noble antagonist, a pseudo-philosophical explanation, and, as such, I have felt, and always shall feel, it my bounden duty to science to warn the public from attaching any serious importance to it. R. Meldola.

The British Museum Catalogue of Birds.

My attention has been drawn to some inaccuracy (no doubt unintentional) in the historical account of the production of the Catalogue of Birds given in a recent number of Nature. Will you, therefore, kindly allow me to correct that account?

At the time of Mr. Bowdler Sharpe's appointment (September 1872) to an assistantship in the Zoological Department of the British Museum, the Keeper of the Department, Dr. Gray, was in so feeble a state of health (consequent on a paralytic stroke) that the administration of the Department had devolved upon Dr. Günther holding the post of assistant-keeper. During the preceding period of his assistant-keepership, Dr. Günther had gone through the whole collection of birds, and formed the opinion that a descriptive catalogue on the lines of his own Catalogue of Fishes ought to be prepared for publication. With this object in view Dr. Günther recommended to the Trustees the appointment of Mr. Sharpe, who, on account of his enthusiasm, energy and general ornithological knowledge, seemed to be specially qualified to undertake the catalogue. Dr. Gray gave his ready consent to the preparation of the catalogue, and the Trustees sanctioned the publication when the MS. of the first volume was laid before them in 1874. Thus, although it is the fact that the preface to the first volume was signed by Dr. J. E. Gray, yet the plan of the work was initiated and elaborated by Dr. Günther, and the work was, during its progress, kept under his constant supervision.

E. Ray Lankester.
Director of the Natural History Departments of the British Museum.
February 1.

Queries on the Reduction of Andrews' Measurements on Carbonic Acid.

To begin with, let me quote a few passages from Andrews' paper. On pp. 301-302 of his "Scientific Papers" he says: "I have not attempted to deduce the actual pressure from the observed changes in the volume of the air in the air-tube. For this purpose it would be necessary to know with precision the deviations from the law of Mariotte exhibited by atmospheric air within the range of pressure employed in these experiments. . . . It will be easy to apply hereafter the corrections for true pressure when they are ascertained, and for the purposes of this paper they are not required. The general form of the curves representing the changes of volume in carbonic acid will hardly undergo any sensible change from the irregularities in the air-tube; nor will any of the general conclusions at which I have arrived be affected by them. It must, however, always be understood that, when the pressures are occasionally spoken of, as indicated by the apparent contraction of the air in the air-gauge, the approximate pressures only are meant."

In every one of his papers specially devoted to the subject he was careful to mention the fact that he was unable to give the true pressures which correspond to the indications of the air- or hydrogen-manometer. The question seems to have hung constantly upon the mind of the experimentalist in the course of his investigations. In spite of this, however, the values of pressure given by him have often been treated as if they were the true values, and in the discussions of the characteristic equation of carbonic acid, agreement or disagreement to within 1/10 of an atmosphere is spoken of. But according to Amagat's measurements on air, hydrogen, or nitrogen, the corrections to be applied are quite large.

In a paper in the *Philosophical Magazine*, vol. xxiii., fifth series, Ramsay and Young have tried, on the basis of Andrews' experiments, to show that in the case of carbonic acid there holds good very approximately the constant volume relation that the pressure under this condition varies linearly as the temperature. They state that they have reduced to absolute units, as far as possible, the values of pressure given by Andrews by means of Amagat's experiments on air. These latter experiments were made at 16°, while the temperature of Andrews' manometer varied within a considerable range, from 5° to 15°. Is the influence of temperature on the manometric correction negligible when the pressure is high? I can show in the case of nitrogen, on the basis of Amagat's experiments, that this auxiliary correction due to temperature variation is generally quite large, sometimes of the same order of magnitude as the main correction itself; and it seems very improbable that in this respect air would differ very much from nitrogen.

The same remark applies to the calculations of Margules (*Wien. Sitzbech.*, xcvii. 2*a*, 1888), and also to my calculations relating to Andrews' measurements on the mixtures of nitrogen and carbonic acid (*Phil. Mag.*, vol. xxxvi. 5th series).

Another point which has for a long time remained a query to me, is the level difference of the mercurial columns in the air and carbonic acid tubes. Let me again quote from Andrews' paper. On p. 303 of his "Scientific Papers" he says: "Having thus ascertained the volumes of the air and of the carbonic acid before compression, at 0° and 760 millims., it was easy to calculate their volumes, under the same pressure of 760 millims., at the temperatures at which the measurements were made when the gases were compressed, and thence to deduce the values of the fractions representing the diminution of volume. But the fractions thus obtained would not give results directly comparable for air and carbonic acid. Although the capillary glass tubes in the apparatus communicated with the same reservoir, the pressure on the contained gases was not quite equal, in consequence of the mercurial columns, which confined the air and carbonic acid, being of different heights. The column always stood higher in the carbonic-acid-tube than in the air-tube, so that the pressure in the latter was a little greater than in the former. The difference in the lengths of the mercurial columns rarely exceeded 200 millims., or about one-fourth of an atmosphere. This correction was always applied, as was also a trifling correction of 7 millims. for a difference of capillary depression in the two tubes." In another place (p. 422) he says: "The pressure in atmospheres, as indicated by the air-manometer, on the gas in the carbonic-acid-tube was given by the equation

$$p = \frac{V_0(1 + \alpha t)}{V_1} \mp \frac{q}{760},$$

in which V_0 is the volume of the air at 0° and 760 millimetres, V_1 the observed volume at the temperature t, and q the difference of level (corrected when necessary for difference of capillary depression) of the surface of the mercury in the manometer and carbonic acid tubes."

Thus what is given as δ or p in Andrews' papers includes in itself the level difference q, and what is really required in calculating the corresponding manometric correction is V_1; q is not given in Andrews' papers. The manometric corrections, then, which are based on the given values of p alone, will differ from what they ought to be by something like ¼ of an atmosphere.

Thus one will find himself prevented from entering upon a

strict reduction of Andrews' measurements at two points, namely, the different temperatures of the manometer and the level difference q. The former might be supplied by making fresh accurate investigations, but will the latter always remain something to be longed for?

The same remark seems to apply to the published results of experiments by Janssen on nitrous oxide, and by Roth on carbonic acid, aethylen, sulphurous acid, and ammonia

Imperial University, Tokyo, Japan. K. TSURUTA.

THE letter above was sent to me some time ago with a request that I should forward it to NATURE after making inquiries as to the possibility of obtaining, from the laboratory books of Dr. Andrews, the desiderata which Prof. Tsuruta points out.

I am delighted to find that one so well qualified is ready to undertake the labour of the necessary reductions; and I will prepare for publication the data required for the purpose. A recent inspection of the Note-books has shown me that they contain the complete details of the *experimental* part of Dr. Andrews' great investigation.

The work is by no means one of mere transcription; it requires great care, and therefore cannot be done in a hurry.

Edinburgh, January 18. P. G. TAIT.

Fourier's Series.

THE difficulty referred to by Prof. Michelson in NATURE of October 6, 1898, and in subsequent letters, to that in your issue of January 19, involves a disregard of the distinction which it is necessary to make between a quantity which, however small it may at first be taken, is thereafter to be kept fixed, and a quantity which can be or is absolutely zero. To this distinction there is the analogous one between a quantity which is arbitrarily large but still considered as limited, and a quantity which is entirely unbounded.

The question considered by Prof. Michelson, interesting as it is, whether the limit, when n increases indefinitely, of the quantity

$$f(\epsilon, n) = \sin\epsilon + \tfrac{1}{2}\sin 2\epsilon + \ldots + \frac{1}{n}\sin n\epsilon,$$

wherein $\epsilon = k\pi/n$ (k fixed and $< 2n$), is $k\pi$, is not really pertinent as a criticism of the usual statement that the sum of the series

$$f(x) = \sin x + \tfrac{1}{2}\sin 2x + \ldots + \frac{1}{n}\sin nx + \ldots \text{ to } \infty$$

is $\frac{1}{2}(\pi - x)$ when $0 < x < 2\pi$ and is 0 when $x = 0$; to get the sum of such a series it is always to be understood (i.) that we first settle for what value of x we desire the sum, (ii.) that we then put the value of x in the series, (iii.) that we then sum the first n terms and find the limit of this sum when n increases indefinitely, *keeping x all the time at the value settled upon*. In the function $f(\epsilon, n)$ above, this condition is not observed; as n increases indefinitely, $\epsilon = k\pi/n$ does not remain fixed, but diminishes without limit. A similar convention is to be observed in other cases. For instance, when a function of x is defined by a definite integral taken in regard to a variable t, the variable x entering as a parameter in the subject of integration; the value of the function is then always to be found under the hypothesis of a specified value for x, which is to be substituted in the subject of integration before the integration in regard to t is carried out. Or, again, in such a common operation as finding the differential coefficient; for instance, we have

$$\frac{d}{dx}\left(x^2\cos e^{\frac{1}{x}}\right) = 2\,x\cos\left(e^{\frac{1}{x}}\right) + \sin\left(e^{\frac{1}{x}}\right) . \, e^{\frac{1}{x}}$$

which is indeterminate when $x = 0$; but the differential coefficient of $f\left(x\right) = x^2\cos\left(e^{\frac{1}{x}}\right)$ at $x = 0$, is not indeterminate; for we have

$$\lim_{h=0}\left[f\left(0+h\right) - f\left(0\right)\right]/h = \lim_{h=0}\left[h\cos\left(e^{\frac{1}{h}}\right)\right] = 0.$$

Another point involved is that a function may continually strive to a limit and yet not reach it. For instance, consider

$$\phi(x) = x^2 + \operatorname*{limit}_{n=\infty}\left(1 - x^{\frac{1}{n}}\right),$$

where it is understood that we are to obtain the value of $\phi(x)$ for any specified values of x by first substituting this value of x on the right side, then calculating the successive values of $1 - x^{\frac{1}{n}}$ for successive finite large values of n, and noticing the limit towards which these values approach indefinitely. When x has any small *specified and fixed* value, however small, it follows, since the limiting value of $\frac{1}{n}$ is 0, that $\phi(x) = x^2$; but when $x = 0$, $x^{\frac{1}{n}} = 0$, and $\phi(x) = 1$. The function thus continually strives to the value 0 as x approaches 0; but it does not reach this value (see also Gauss, "Werke," iii. p. 10). Unless I mistake Mr. Hayward's letter of January 19, there is a similar point there involved. The point P (in the sixth line of his letter from the bottom) strives to the point $\left(\pi, \frac{\pi}{2}\right)$; in the sense in which the sum of a Fourier series is understood, it does not reach this point.

The discontinuity of the sum of the Fourier series considered above is explained by the fact that as x is taken near zero the convergence becomes indefinitely slow; the sequence of values of n necessary to make $s - s_n$ of assigned smallness has infinity for (an unreached) upper limit.

I should be glad to take this opportunity of referring to a point intimately connected with the considerations above, in regard to which most of the accounts in the text-books appear capable of more definiteness. The condition[1] that a sequence of finite qualities $s_1, s_2, \ldots, s_n, s_{n+1}, \ldots$ should tend to a limit is that for any specified small ϵ it be possible to find a finite m, such that for $n > m$ and *for all values of p* the absolute value of $s_{n+p} - s_n$ should be less than ϵ. The question may be asked: Does *all values of p* mean only all finite values however great (arbitrarily or indefinitely but not infinitely great), or is the value $p = \infty$ supposed to be required. There is no doubt the phrase may be limited to mean *all finite values of p, however great*. Thus taking the function $\phi(x)$ above, and putting, what is in accordance with the condition as now stated, $s_n = \phi\left(\frac{1}{n}\right)$, the sequence of quantities $\phi\left(\frac{1}{n}\right)$ defines a value, namely zero, which we may quite fairly describe as the limit of the sequence. Though we may also say, in a certain sense, that this limit is not reached; in fact, the value s_∞, regarded as $\phi(0)$, is 1. And, further, the series

$$u_1 + u_2 + u_3 + \ldots$$

wherein

$$u_1 = 1,\ u_n = \phi\left(\frac{1}{n}\right) - \phi\left(\frac{1}{n-1}\right)$$

is convergent, and its sum is the limit of the sequence $s_1, s_2, \ldots, s_n, \ldots$, namely zero; and this notwithstanding that $s_\infty = 1$. A more striking case is got by replacing $\phi(x)$ by

$$\psi(x) = x^2 + \lim_{n=\infty}\left(1 - x^{-\frac{1}{n}}\right),$$

The phraseology is analogous to the usual one for a definite integral; for instance, the integral

$$\int_\zeta^x \frac{dx}{x[\log x^{-1}]^{1+\sigma}},$$

wherein x is less than 1, and σ is positive, has a definite limit when $\zeta = 0$; for whatever assigned value ϵ may have, it is always possible to find a positive value for ζ, such that for any positive value of ζ_0 less than ζ the integral

$$\int_{\zeta_0}^\zeta \frac{dx}{x[\log x^{-}\ ]^{1+\sigma}}$$

is numerically less than ϵ. This statement is, however, made with the proviso that ζ_0 is not to be taken zero or infinitely near to zero, though it may be taken as small as we please; it is indefinitely small without being infinitely small. If ζ_0 were taken zero, the last integral would, strictly, be meaningless.

If only for the purpose of showing that the notion of an

[1] See, for instance, the excellent book of Harkness and Morley, "Introduction to Analytic Functions" (January 1899; Macmillan and Co.), which is surely unequalled for the matters of which it treats.

unattained limiting value is not new-fangled, it appears worth while to quote a few words of the paper of Gauss, above referred to, which is of date 1799.

"Ex suppositione, X obtinere posse valorem S neque vero valorem Π, nondum sequitur, inter S et Π necessario valorem T jacere, quem X attingere sed non superare possit. Superest adhuc alius casus: scilicet fieri posset, ut inter S et Π limes situs sit, ad quem accedere quidem quam prope velis possit X, ipsum vero nihilominus nunquam attingere."

It is a curious enough fact of history that it is Weierstrass's use of this principle which has destroyed the Dirichlet proof of a fundamental theorem of the theory of potential (Thomson and Tait's "Natural Philosophy," 1879, vol. i., first line of p. 171). H. F. BAKER.

Cambridge, January 23.

The Aurora of September 9, 1898.

I OBSERVE, from NATURE, that an auroral display was visible in the South of England on the evening of September 9. It may interest some of your readers to know that an aurora was seen here on the evening of September 10. The display began at about a quarter to eight o'clock, and lasted for an hour or so. The whole southern heavens at first became suffused with a bright orange light low down upon the horizon, from which a few streamers issued from time to time, rising (judging by the eye) to a height of, say, 45 degrees above the horizon. When both glow and streamers had faded away, I noticed three luminous clouds, one at the zenith. The largest of these clouds increased in size, and shot forth a few streamers of light, both upwards and downwards, and all then disappeared. I have witnessed several auroral displays at Ashburton, but none like that of September 10, the distinguishing features of which were the orange glow and the luminous clouds.

On the following day, my telephone, which had never failed me before, worked irregularly, and some of the other telephones in the town were similarly affected. CHAS. W. PURNELL.

Ashburton, Canterbury, N.Z., December 21, 1898.

THE APPLICATION OF PHOTOGRAPHY TO THE STUDY OF THE MANOMETRIC FLAME.

THERE are few more beautiful phenomena in experimental physics than those presented by the image of the manometric flame as one sees it in the revolving mirror. Especially is this true when the flame is excited by means of the complex tones of the human voice or by some musical instrument such as the violin, which possesses pronounced and varying tone colour.

Little use, nevertheless, has been made of the flame as an implement in research. Indeed the whole of the early literature pertaining to the manometric flame may be said to consist of the three papers[1] in which, at intervals of ten years, Rudolph Koenig described the apparatus which he first made public at the London Exhibition of 1862, together with the various experiments to which it was adapted. The writers of text-books, it is true, have made free use of Koenig's beautiful method, but investigators have been slow to avail themselves of it. The use of sensitive flames in the stroboscopic study of vibrations by Toepler (*Poggendorff's Annalen*, vol. cxxviii. p. 108, 1866), which method has since been employed by Brockmann (*Wiedemann's Annalen*, vol. xxxi. p. 78, 1887) in his analysis of the movement of the air in organ-pipes, and also the observations of singing and of sensitive flames by Kundt (*Poggendorff's Annalen*, vol. cxxviii. p. 337 and p. 614, 1866); by Barrett (*Philosophical Magazine*, 1867); and by Tyndall ("On Sound," Lecture vi., 1867), belong to this period. These researches, however, form a class by themselves, and are to be traced back to the earlier work of Higgins (1777), Chladin (1802), De la Rive (1802), Faraday (1818), Wheatstone (1832), Schaffgotsch (1857), and Le Conte (1858). In them the use of the manometric capsule does not occur, and they appear, from first to last, to be entirely independent of the work of Koenig.

[1] Koenig, *Poggendorff's Annalen*, vol. [illegible] p. [illegible]; vol. cxlvi. p. 161; "Quelques Expériences d'Acoustique," Chapter vii.

The difficulty of securing a trustworthy record of the forms taken on by the flame-image has doubtless had much to do with this hesitancy. The drawings published by Koenig to accompany the description of his experiments are of great beauty, and the more intimately one is acquainted with the appearance of the flame-image itself, the more one is impressed with the extraordinary fidelity of these representations of it. The secret of their accuracy is to be found in the method by which they were obtained, which is described by Koenig in the article of 1872, to which reference has already been made. In the preparation of the well-known plate of the drawings of flame-images corresponding to the five principal vowel sounds, which was exhibited at the annual meeting of German Men of Science (*Naturforscherversammlung*, Dresden, 1868) each vowel was sung at a carefully ascertained pitch, and duplicate drawings were made by Koenig himself and by a draughtsman employed for that purpose. When these two drawings were found to be alike they were assumed to be correct, but wherever a variation occurred the experiment was repeated until the two were brought into agreement. Each vowel was sounded with a pitch corresponding to each note of the scale between ut_1 and ut_3, so that seventy-five of these drawings, perfected by many repetitions, appear in this one plate.

The most complicated of the pictures of the manometric flame drawn by Koenig is that shown in Fig. 1,

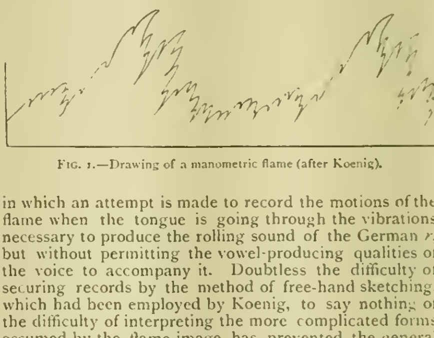


FIG. 1.—Drawing of a manometric flame (after Koenig).

in which an attempt is made to record the motions of the flame when the tongue is going through the vibrations necessary to produce the rolling sound of the German *r*, but without permitting the vowel-producing qualities of the voice to accompany it. Doubtless the difficulty of securing records by the method of free-hand sketching, which had been employed by Koenig, to say nothing of the difficulty of interpreting the more complicated forms assumed by the flame-image, has prevented the general introduction of what in other respects is a very attractive method of research.

In 1886 the question, which must have occurred to many observers of the manometric flame, whether these fleeting flame-images could be photographed, was answered affirmatively by Doumer (*Comptes rendus*, vol. ciii. p. 340; vol. cv. p. 1247), who used such photographs in the determination of pitch and of the phase relations of sound waves. Doumer, however, published none of his photographs; so that we do not know what degree of success he attained. In 1893 Merritt, who was at that time unacquainted with Doumer's experiments, undertook the photography of the manometric flame in the hope of thus developing a method which would be of use in connection with certain studies in phonetics. His paper, entitled "A Method of Photographing the Manometric Flame, with Applications to the Study of the Vowel A" (*Physical Review*, vol. i. p. 166), contains the first published photographs of the Koenig flame-images. Merritt found it barely possible to photograph, upon a rapidly moving plate, the flame produced by the ordinary Koenig apparatus. The actinic weakness of the flame

was such that the development of the under-exposed plates was exceedingly laborious, and the results were most unsatisfactory. He turned his attention, therefore, to increasing the actinic effect by the use of a burner in which the flame, at first of ordinary illuminating gas, was surrounded by pure oxygen. With this form of burner, a diagram of which is given in Fig. 2, photographs were readily obtained upon a moving plate, in which the salient features of the images described by Koenig were clearly brought out. The gas was subsequently enriched by passing it through a receiver of petroleum ether, and in this way the brilliancy of the flame was further greatly increased. In Merritt's experiments the moving plate was shot horizontally through the field of the camera at a speed sufficient to separate properly the various flame-images. The speed of the plate-holder, which was arranged to slide between guides, was about two metres per second. The entire time-period covered by the chrono-photographs thus produced was only a few hundredths of a second.

Chrono-photographs of the manometric flame have since been made by Hallock and Muckey (*The Looker On*, 1896, pp. 1, 177 and 375, 1896), who used such flames, excited by resonators, in the analysis of the voices of various opera singers; by the writer in collaboration with Prof. Merritt (*Physical Review*, vol. vii. p. 93, 1897),

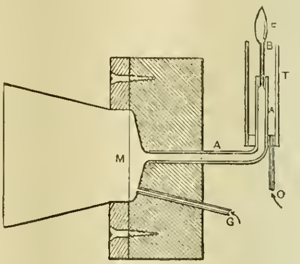


Fig. 2.—Merritt's burner [the diaphragm is at M; illuminating gas enters at G; oxygen at O].

and by Miss J. A. Holmes (*Thesis*—in manuscript—Library of Cornell University, 1898).

Acetylene gas, which has come into common use since the experiments just described were made, affords a light of much greater actinic power than any which was formerly available. The flame of burning magnesium alone surpasses that of acetylene in brilliancy. The carbon bands in the electric arc, to be sure, give that source of light, likewise higher actinic value than the acetylene flame; but the arc light cannot be used manometrically, nor, indeed, is it probable that the magnesium flame could be thus employed.

When we surround the acetylene flame with pure oxygen in a burner, like that described by Prof. Merritt, its actinic power is still further increased.

In 1897 the writer spent many pleasant hours of the summer vacation with Prof. Merritt in the fascinating work of photographing the manometric flame. The experiments of 1893 were repeated with acetylene in place of ordinary enriched burning gas, and with films of considerable length instead of the glass plates. The manometric burner was the same in all essential features as that described by Merritt in the article which I have just cited. It was supplied with a mixture of equal volumes of acetylene gas, generated by the action of water upon calcium carbide in the usual manner, and of hydrogen. The chrono-photographs were taken upon films 120 cm. in length, which for convenient handling were mounted in an especially constructed camera. This camera consisted of the usual lens and bellows, and of a rectangular box of wood containing a drum D (Fig. 3), upon the periphery of which the film was mounted. The drum could be driven at a convenient speed, either by means of a belt attached to an electric motor, as shown in the diagram, or, as was sometimes found to be more convenient, by hand. The box which contained the drum was light-tight, excepting that at a position suitable to allow the passage of the rays from the lens there was a vertical slit closed by a shutter. This shutter could be opened electrically by an observer stationed at the manometric flame, after which it remained open for precisely one revolution of the drum. When this revolution was completed, the shutter closed automatically.

The revolving drum, which carried the sensitised film upon which the photographs of the flame were taken, was given a speed in most of our experiments of about one revolution per second. This was found to be quite sufficient for the proper separation of the flame-images, and it permitted us to record upon a single film any word or phrase the utterance of which did not require more than a second of time. In certain cases, where we desired to include in the chrono-photograph polysyllabic words or phrases, the speed was somewhat reduced; in other cases, for the purpose of a further separation of the flame-images, the drum was driven at a much higher velocity.

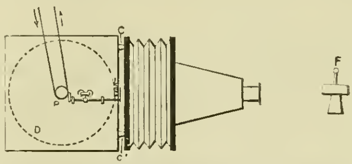


Fig. 3.—Camera for photographing the manometric flame. [The flame is at F; the revolving drum is represented by the dotted circle D.]

In the manner just described a large number of striking photographs were obtained, the beauty and sharpness of detail of which no adequate idea can be given in the printed reproduction. It was found that the repetition of the same combination of articulate sounds, uttered at the same pitch and by the same speaker, always gave very closely indeed the same series of flame-images. Nevertheless the reading and interpretation of these photographic representations of the manometric flame is by no means a simple matter. When we attempt to read such a record, as one would read the trace of the syphon recorder in a telegraphic message, or as one would read shorthand, we find that it is only the vowels which produce any marked agitation of the flame. All those accompanying mouth-sounds which introduce and close each syllable in articulate speech, and by which, in great measure, we are able to distinguish the different words, produce a very feeble and often an unrecognisable effect upon the flame. The records are indeed the very opposite of shorthand writing, not only in that instead of a single character to a syllable, we have sometimes as many as a hundred oscillations of the flame, but likewise in the fact that while shorthand is made up of words with the vowels left out, these manometric photographs represent speech with the consonants suppressed. It is obvious that to read a record of the latter sort, even after the eye had been trained to recognise the flame-groupings characteristic of all the vowel sounds, is more difficult than it is to pick out words in which the consonants are indicated and the vowels omitted.

There is in the interpretation of the flame photographs

a further difficulty which is clearly brought out in the famous chart of drawings exhibited by Koenig in 1867. This difficulty is due to the fact that the characteristic grouping for each vowel differs with the pitch at which the sound is uttered, and that no two speakers sound the vowels in precisely the same manner, each one having his personal peculiarities of voice. Fortunately it is not necessary to learn to read them in this way, since their interest lies chiefly in the completeness with which they serve to show a multitude of details and peculiarities of articulate speech, which cannot be so directly studied in any other manner.

Not only are the subtle differences which distinguish the vowel sounds uttered by persons speaking various dialects manifested by differences in the flame groupings, but, as I have just pointed out, the individual peculiarities in the utterance of different speakers using the same dialect are plainly discernible. We have, moreover, in the record of each individual syllable, most interesting evidence of the gradual formation of the full vowel sound as the mouth opens at the beginning of the syllable, and the modification of the sound again as the mouth closes at the end. Another peculiarity which the reader of the manometric records encounters, lies in the fact that the pauses between words in ordinary speech are often of no greater duration than pauses between syllables of the same word. There is thus no way of separating words from one another until the record has been interpreted, and each group of flame-images has been assigned its place in the phrase. This difficulty is akin to the one with which we meet when, with unaccustomed ears, we try to distinguish for the first time the spoken words of a foreign language. The flame record does, on the other hand, for the reader what the printed page does not do. It shows clearly by means of the strength of oscillation into which the flame is thrown, which syllables are accented and which are unaccented by the speaker; and more than this, it is capable of indicating the degree of emphasis placed upon each syllable, and of recording faithfully those only too numerous cases in which we slur over, in careless speech, portions of a word which should perhaps be clearly enunciated

It is unfortunately not possible to illustrate these points of interest without the use of very large plates. To show properly the record of a word or phrase containing four syllables, the photograph must be at least one metre in length. It is only possible to clip here and there an interesting passage from the records by way of illustration of the appearance of the photographs which may be obtained. These passages are of necessity very brief, covering a time interval in each case of less than two-tenths of a second. One cannot even give the record of a single complete, deliberately spoken syllable upon a plate of the width of a page of NATURE.

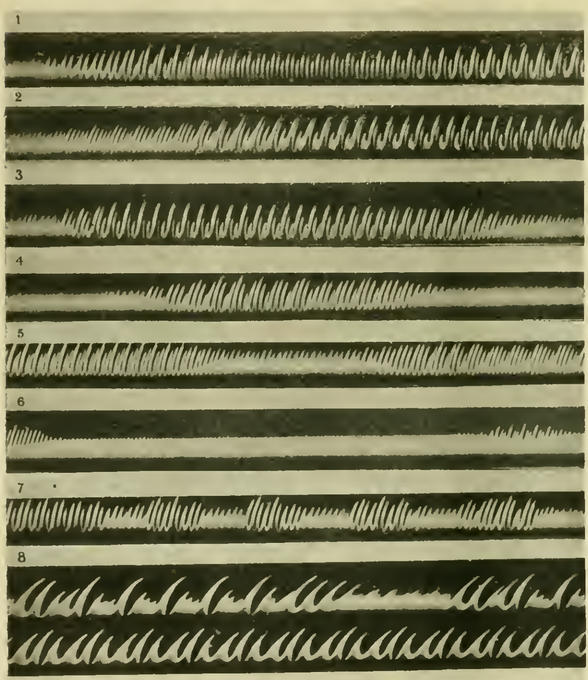


FIG. 4—Specimens of chrono-photographs of the manometric flame. [The original width has been reduced by one-third.]

The photograph numbered 1 in Fig. 4 is the first part of the record obtained when the syllable *dä* (as in dart) is deliberately spoken. It shows the gradual formation of the serrated image as the mouth opens, which reaches its maximum of strength immediately thereafter. This is followed by a short interval, which may be called the *interval of adjustment*, during which the mouth is being brought into a position to utter the vowel properly. At the extreme right-hand the first vibrations due to the fully-developed vowel sound are to be seen. This photograph gives about one-third of the complete record obtained from such a syllable.

No. 2 shows in like manner the formation of the syllable *ah*, deliberately spoken, in which the mouth opens more slowly and the formation of the vowel is preceded by a characteristically different set of flame groupings. This trace is likewise cut off for lack of space, so as to show only the first third of the syllable.

No. 3 shows the whole of an accented syllable in a rapidly spoken word. The word in this case was *preposterous*, and the syllable selected for illustration here is the antepenultimate *pos*.

No. 4 shows a syllable still further shortened by rapidity of speech, namely *tan* at the end of the word *Raritan*.

No. 5 is a small portion cut from the middle of the record obtained from the word *river*. It is introduced into the plate for the purpose of showing the partial interruption of the vibrations due to the sounding of the *v* in the middle of this word. It is interesting to note likewise the gradual modification of the vowel sounds before and after *v* as the mouth closes and opens again.

The interruption due to this consonant is probably the least marked of any. The pronunciation of *b*, *d*, *t* and other consonant elements in the middle of words usually causes a more or less complete cessation of oscillations on the part of the flame for a considerable period of time.

No. 6 shows the record for the ending of the word *doctor*, spoken hurriedly. The photograph shows the behaviour of the flame from the moment when the first vowel sound is just being cut off by the closing of the mouth for the enunciation of that portion of the word represented by the letters *ct*. The whole of the last syllable, which is almost completely suppressed and slurred over, as is too often the case in every-day speech, is shown. The period of quiescence in this instance is greater than that which takes place between the successive words of a sentence spoken in the ordinary manner. This peculiarity has already been referred to in a previous paragraph.

No. 7 is a portion of the photographic record of the word *Raritan*, comprising the closing vibrations due to the first vowel sound *a* and the transition of this into the form of the rolling *r* which follows. The letter *r* was given a much stronger roll in speaking this word than is customary in English, for the purpose of studying the flame record thus obtained. Each contact of the tongue to the roof of the mouth in the production of the trill is shown in the flame record by a partial blotting-out of the serrated image.

No. 8 shows the results obtained when the speed of the film was increased to five metres per second. The upper line of flame-images is that obtained from a continuously sounded rolling *r*. It is possible in this instance to show only the details of a single member of the series of trills which make up this complex sound. The lower record, which was taken upon the same film and at the same speed, is that of the vowel *a* flat (as in cat) continuously sounded throughout the entire revolution.

It is the writer's opinion that very interesting and possibly important results might be obtained by the use of longer films driven at even higher rates of speed. There are indications, in certain of the photographs obtained in the course of the experiments just described, of vibrations of higher pitch, which are not properly separated from one another even at the speed of five metres per second. EDWARD L. NICHOLS.

Cornell University.

THE STUDY OF TROPICAL DISEASES.

THE *Geographical Journal* for December contains an interesting monograph, by Dr. Wistenra Sambon, upon the acclimatisation of Europeans in tropical lands. The subject-matter of this paper was discussed at the Royal Geographical Society last April, and various opinions were expressed upon it. Dr. Sambon is, further, the author of other communications dealing with this question. Put briefly, his contention is that there is nothing inimical to Europeans in tropical climates which cannot be prevented by hygienic measures. The two main characteristics of the tropical climate, viz. heat and moisture, are practically never *per se* the cause of disease, nor do they *per se* cause any deterioration in either the colonists themselves or their progeny. The mass of the so-called diseases of tropical climates has a parasitic origin. The enormous number of deaths from malaria in the unhealthy regions of Africa, and from snake-bite in India, are quoted by the author as examples of this. Even heat-stroke is, according to him, of parasitic origin. Further, not only is the great enemy to colonisation after actual occupation, the microbe, but the same agency comprises the great difficulty in colonisation. For instance, in the French Expedition to Madagascar in 1896, only seven men were killed by Hovas, and ninety-four wounded; the deaths due to pathogenic micro-organisms numbered 6000, and the sick list from the same cause 15,000. From these facts the contention is that all we have to do in order to make Europeans thrive in the tropics, is to exterminate the pathogenic micro-organisms which are the cause of so-called tropical disease; these once subjugated, and Europeans could live in the tropics like natives.

How this is to be done is naturally the difficulty. In the case of the malarial parasite, for instance, should we set about producing immunity, or destroying the parasite in the most exposed phase of its life-history? The latter method is the one which recommends itself as being, if the most difficult, at the least the most radical; hence the importance of the minute study of the life-history of each pathogenic parasite.

To render Europeans capable of supplanting natives in tropical countries is more, as Sir Harry Johnston pointed out, than we want. The desideratum is to render a relatively small number of Europeans capable of ruling the tropics. The limited knowledge we now possess of the means of curing tuberculosis, and of exterminating the tubercle bacillus, even although some of our best workers and thinkers have devoted themselves to the subject for more than a quarter of a century, prevents the most sanguine of us from expecting that the means of exterminating the malarial parasite will be hit in the immediate future. In spite, however, of this, no one can legitimately doubt that the careful study of the life-history of the parasite, and the nature of the so-called predisposition to malaria, will avail much in lowering the European death rate in the malarial regions of the tropics.

In this connection, it is interesting to note that there will, before long, be established in London an institution for the study of tropical disease. This institute will have a double function, viz. education and research. Use will be made of the clinical material of the port of London for teaching qualified medical practitioners who, either as members of the Government services, or as private individuals, intend practising in the tropics. In addition, research work upon the nature and causation of tropical disease will be undertaken and encouraged. The founding of this institution, as is invariably the case, has not been free from difficulties. Some of these, if not all, are probably by this time well known to the public, as, after a preliminary statement of grievances in the medical press, a lively correspondence has been devoted to this subject in the *Times*.

The site of the institute has been fixed at the branch hospital of the Seamen's Hospital Society, between the Royal Victoria and the Albert Docks. Upon the school buildings and enlargement of the hospital 13,000*l*. is to be spent, towards which the Colonial Office contributes 3350*l*. The maintenance of the school and the additional beds is estimated at 3050*l*. per annum, of which 1000*l*. will be paid annually by the Colonial Office in fees for the instruction of its students. The curriculum to be followed at the schools is to be arranged by a committee of experts.

The opposition to the scheme chiefly arises from three sources. The established medical schools, or rather their representatives, say that, both with regard to clinical material and laboratory accommodation, there is no need to go to the expense of building and instituting a new school. The staff of the Dreadnought Seaman's Hospital, of which the hospital which is to be metamorphosed into the new school is a branch, agree in the main, and emphasise the incongruity of choosing a relatively small hospital to the exclusion of the parent hospital and its staff. A third class of opposition, which may be described as unattached, appears in the form

of Mr. Hutchinson, who has written a powerful letter to the *Times*. In this letter he sets forth how easy it would be to arrange to use the clinical material at the docks in connection with an institution which is at present appealing to the public for funds, viz. the Post-Graduate Medical Polyclinic in Chenies Street, Gower Street. Mr. Hutchinson points out that lectures will probably be delivered at the Albert Docks by professors living in the immediate neighbourhood of Harley Street, and be listened to by students living in the neighbourhood of Gower Street; hence much time will be lost both by teachers and taught, who could obviously come together, for everything except actual bed-side teaching, upon more convenient premises, viz. those of the Post-Graduate College. On the other hand it is contended, on the part of the promoters of the Home Secretary's scheme, that what is required is a school entirely devoted to the study of tropical medicine, where students shall do nothing else, and shall give their whole time to this branch of medicine. It cannot be denied that living in the atmosphere of a subject is greatly conducive to the quick acquisition of a knowledge of it. How this result is brought about is not quite so clear; it seems to be a kind of intellectual osmosis. Apparently what the Home Office want is to run their candidates quickly through somewhere where they can quickly gain a good knowledge of tropical medicine, and be then able to materially aid colonisation. They do not want the time of their candidates wasted in going here for lectures, there for clinical cases, and somewhere else for bacteriology. Whether the extra expense involved in concentrating all the requisites for this special education under one roof will be money spent to the greatest advantage from the point of view of general medical education, is perhaps questionable. The scheme will, however, appeal to the commercial and philanthropic interests involved as business-like, and will probably receive their support. It is to be hoped that neither the local interests of medical cliques on the one hand, nor the colossal dignity of the College of Physicians on the other, will prevent the whole medical profession co-operating to the attainment of a thorough knowledge of tropical medicine by all those who intend to be concerned in its practice.

SOILS FOR ARTIFICIAL CULTURES.

AN increasing amount of experimental work on the growth of plants is being done by means of cultures in artificial soils. It is quite clear that the success of investigations so conducted must largely depend on the perfect suitability of the soil for the production of a full and normal growth. Little attention is, however, frequently given to this point. It is, in fact, often assumed that a pure quartz sand watered with a nutritive solution supplying phosphates, sulphates and chlorides, of potassium, calcium, magnesium and iron, is a fit and proper soil, and that any deficiency of luxuriance in plants grown in such a medium is due to some special circumstance unconnected with the general conditions of the experiment.

Whether some plants are capable of reaching a fair development when placed under the conditions just described is hardly the question; the point on which I wish to lay stress is that such a soil is in several respects a most unnatural medium for plant growth, and is thus generally unsuited for purposes of investigation.

The salts just named are often spoken of as constituting a "full mineral supply," and the conditions described are reckoned as quite suitable for the culture of a leguminous plant, which derives its nitrogen from the atmosphere, if only the organism producing nodules on the roots is also introduced. It is quite true that the salts in question, if applied to an ordinary arable soil, would furnish an adequate supply of the ash constituents demanded by the plant; but in this case the form in which they would reach the plant would be entirely different from that which occurs in the case of the artificial soil of quartz sand.

In the natural soil, containing calcium carbonate, hydrate silicates, and hydrate ferric oxide, all the alkali salts applied as manure are decomposed; their acids combine with the lime of the soil, and their bases are held in feeble combination on the surface of moist silicates and ferric oxide, from which they are easily extracted by the acid sap of the root hairs. What an immense difference this must make to the plant! In the first place, there is no hurtful excess of saline matter in the soil. The potash has been precipitated upon the surface of the soil particles, while the acid it was formerly combined with has been carried off united with lime in the drainage water. In the next place, the plant is well provided with bases with which the organic acids which it is constantly producing can combine. This is surely a most important point. What can a plant do that is fed on chlorides and sulphates in a mass of pure quartz? How can it get rid of the acids, and obtain bases to supply its own wants? It must be, at least, a very slow and painful business. In a natural fertile soil, not only are the alkalies, as already mentioned, largely supplied to the plant as bases, but the soil water itself always contains a quantity of calcium carbonate dissolved in carbonic acid.

That a plant does require this supply of bases is evident from the character of plant ash. The ashes of plant leaf and stem are always of an alkaline character; those from leguminous plants are highly alkaline, and consist chiefly of carbonates, the residues of the salts of organic acids which have been destroyed on ignition.

The immense improvement in the luxuriance of an artificial culture in sand which is observed when a nitrate is added to the nutritive salts employed, is not to be entirely attributed to the supply of nitrogen thus given. The nitrate is, in this case, the only salt which can supply the plant with a base, and its addition to the soil thus greatly improves the general conditions of growth. The nitrate acts in this way because the nitric acid is employed in the plant for the production of nitrogenous organic matter, and its base at once becomes available for combination with organic acids.

For most experiments there is no necessity for employing the favourite mixture of quartz sand and soluble inorganic salts. Any fertile sandy soil may be used as well, and can be as thoroughly sterilised if sufficient care be taken, but it should not be dried or burnt if its special chemical properties are to be retained. If the nearly complete absence of organic matter is desired, the sand can be taken two feet below the surface.

If an artificial soil is needed, the quartz sand should in every case be mixed with 2–5 per cent. of calcium carbonate. Powdered felspar is an excellent addition to an artificial soil The mixture must also have a sufficient power of holding water; the sand must, therefore, be fine. If the conditions of the experiment do not forbid it, some humic matter should be supplied. Mr. Mason, who has been very successful with cultures in artificial mixtures, adds 1 per cent. of moss-litter to his soils. The water in natural soils always contains carbonic acid. This point also must not be forgotten, especially when no addition of humic matter has been made. R. WARINGTON.

NOTES.

ON Monday at Osborne the Queen held a private investure of the Orders of the Bath, St. Michael and St. George, and the Star of India. Sir William Roberts-Austen, K.C.B., and Sir William Thiselton-Dyer, K.C.M.G., had the honour of knighthood conferred upon them. Sir Charles Cameron received the decoration of the civil division of the third class of the Order of the Bath.

PROF. MENDELÉEFF has been elected a corresponding member of the Paris Academy of Sciences, in succession to the late Prof. Kékulé.

PROF. E. RAY LANKESTER, F.R.S., has been elected Foreign Associate of the Royal Academy of Sciences, Arts, and Belles Lettres of Belgium, in succession to the late Prof. Leuckart, of Leipzig.

M. DYBOWSKI, director of agriculture in Tunis, and professor at the Agronomic Institute, has been appointed director of the colonial garden about to be established at Vincennes upon the plan of the Royal Gardens at Kew.

M. MILNE-EDWARDS, director of the Paris Natural History Museum, has been promoted to a commandership of the Legion of Honour. Among the new chevaliers of the same order are Prof. Floquet, of Nancy; Dr. Hanriot, member of the Paris Academy of Medicine; Prof. Dufet, of the lycée Saint-Louis; and Prof. Desmons, professor of mathematics at the lycée Janson-de-Sailly.

THE COUNCIL of the Manchester Literary and Philosophical Society have awarded the Wilde Medal of the Society for 1899 to Sir Edward Frankland, K.C.B., F.R.S., and the Wilde Premium for 1899 to Dr. Charles H. Lees. The Wilde Lecture will be delivered by Prof. W. Ramsay, F.R.S., on February 28, when the presentation of the medal and the premium will also be made.

THE Marquis of Salisbury has forwarded to the Mayor of Dover (Sir W. H. Crundall) a subscription of 100*l.* towards the fund for entertaining the members of the British Association on the occasion of their meeting at Dover this year.

REUTER reports that the Emperor of Russia has granted the Russian Geographical Society the sum of 42,000 roubles towards the fitting out of a scientific expedition to Central Asia.

DR. FLEURENT has been appointed professor of industrial chemistry at the Paris Conservatoire des Arts et métiers, in succession to the late M. Aimè Girard.

THE municipal council of Nuits-Saint-Georges, Department of Côte-d'Or, have decided to erect a monument in honour of M. Tisserand, the distinguished astronomer and late director of the Paris Observatory, and have voted a sum of one thousand francs towards it. M. Tisserand was born at Nuits-Saint-Georges on January 13, 1845, and the erection of a monument in his native town will be an appropriate memorial of his scientific work. A strong patronage committee, having the Minister of Public Instruction and Fine Arts as honorary president, and M. Faye as president, has been formed. The president of the organising committee is Dr. Boursot, Mayor of Nuits-Saint-Georges, and the treasurer is M. Desmazures, the municipal receiver of that town. Admirers of Tisserand's work are invited to send to M. Desmazures subscriptions in aid of the memorial which it is proposed to raise.

DR. H. N. STOKES has been elected president of the Chemical Society of Washington.

THE American Academy of Arts and Sciences has elected Prof. C. D. Walcott, of Washington, an Associate Fellow in succession to the late Prof. James Hall, and Mr. Oliver Heaviside, F.R.S., a Foreign Honorary Member.

WE regret to see the announcement of the death of the Rev. Thomas Hincks, F.R.S., distinguished by his works in several departments of marine zoology.

THE annual general meeting of the Physical Society will take place on Friday, February 10. The Royal Astronomical Society will hold its anniversary meeting on the same day.

THE *British Medical Journal* announces that Prof. William Osler, F.R.S., of the Johns Hopkins University, Baltimore, has accepted an invitation to deliver the Cavendish lecture for 1899, before the West London Medico-Chirurgical Society.

THE Paris correspondent of the *Times* states that the selection, by the Institution of Civil Engineers, of M. Picard, Commissioner-General for the Paris Exhibition of 1900, as an honorary member in succession to the well-known ironmaster, the late M. Schneider, of Creusot, has given great satisfaction in Paris.

REUTER reports that an earthquake, lasting three minutes, occurred in Mexico at nine minutes past five in the afternoon of January 24. The earth-movement was partly from north-east to south-west, and partly from north-west to south-east. More than two hundred buildings were seriously damaged, and ten houses completely collapsed.

SIR WILLIAM MCGREGOR, K.C.M.G., who has been appointed Governor of Lagos, is an M.D. of the University of Aberdeen, and has held various medical appointments in Scotland and the Colonies. In 1888 he was made the first Administrator of British New Guinea, and in 1895 Lieutenant-Governor of the Colony, a post he has held up to the present time. He has received the honorary degrees of LL.D. from Aberdeen, and of D.Sc. from Cambridge.

THE *Lancet* states that the occasion of the delivery, by Sir William MacCormac, of the Hunterian Oration at the Royal College of Surgeons of England this year will be distinguished by the presence of the Prince of Wales, who has also consented, at the president's invitation, to dine with the College the same evening. It is not the first time that the Prince of Wales has honoured the Hunterian orator by attending the delivery of the oration. He was present when Sir James Paget and Mr. Bryant were the orators.

WE have already mentioned the retirement of Prof. Alexander Agassiz from the directorship of the Museum of Comparative Anatomy at Cambridge (Mass.). It appears that Prof. Agassiz's resignation was accompanied by conditions which covered a deed conveying to the President and Fellows of Harvard College munificent gifts of natural history collections. Arrangements have been made by which the late director will have the use of certain rooms and storehouses, as well as a claim on the clerical services of some members of the museum staff. In addition to the collections, there are handed over, as late personal belongings, all the copies remaining in stock of the volumes of the *Bulletin*, and of the *Memoirs*, together with all the publications received in exchange for these issues, about 3500 volumes, and the books which Prof. Agassiz has purchased during the past twenty years, about 5000 volumes. Prof. Agassiz intends now to devote his time to explorations and the publication of reports of these undertakings.

THE twenty-sixth annual dinner of the old students of the Royal School of Mines, with Mr. F. W. Harbord, metallurgical chemist to the Indian Government, in the chair, was held on Friday last, January 27, at the Hôtel Cecil. Of the Professors, Sir W. Roberts-Austen, Rücker, Tilden, and Howes were present, and about 120 of the past and present students. The Chairman, in proposing the chief toast—that of the mining and metallurgical industries—dwelt upon the modern conditions of capital, labour, transport and education, and their bearing on the old students who had to direct those industries. Other speakers were Prof. Roberts-Austen, Prof. H. McLeod, Prof. A. W. Rücker, Sir H. Trueman Wood, Mr. R. C. Styles, Mr. L. C. Stuckey, Mr. Bennett H. Brough, Colonel J. Pennycuick, Mr. Bedford McNeill, and the honorary secretary, Mr. H. G. Graves.

THE British Fire Prevention Committee has just opened its testing station at Regent's Park. The arrangement of the establishment are in the hands of the executive of the Committee, Mr. Edwin O. Sachs (the chairman) personally supervising the work, with the assistance of a sub-Committee, comprising Mr. R. Mond, Mr. Farrow, and Mr. Max Clarke. The purpose of the tests, as defined by Mr. Sachs at Tuesday's press view, is to obtain trustworthy data as to the exact fire-resistance of the various materials, systems of construction, or appliances used in building practice. Such data have not as yet been available, owing to the fact that nearly all investigations of this description have been carried out by individual makers or inventors with specific commercial objects in view. The tests will be of an entirely independent character, arranged on scientific lines, but with full consideration for the practical purpose in view. All reports on tests will solely state the bare facts and occurrences, with tables, diagrams and illustrations, and on no account will reports include expressions of opinion or any expressions that might be read as comparisons or criticisms. The general direction of the tests will be in the hands of the executive, the actual tests being attended by the members of the Council and the members of the Committee in rotation. The principal building of the testing station will be used for laboratory purposes, whilst the gardens are utilised for the principal so-called "full-size" tests. These are generally carried on in brick chambers specially erected for the purpose. The fuel primarily takes the form of gas, and the principal recording instruments are the Roberts-Austen electrical pyrometers with photographic records.

REFERRING to the death of Prof. Gurlt, at Berlin, the *Lancet* remarks that as permanent secretary of the German Surgical Association he had to make the arrangements for the annual meetings of this important society and to publish its proceedings. During the last few years he had the management of the collective investigation on anæsthetics. His name will always be famous as one of the historians of surgery. Scarcely a year before his death he published his great work on the "History of Surgery during the Middle Ages and the Renaissance," the result of more than ten years' study. Prof. Gurlt was the editor of the *Archiv fur Klinische Chirugie*, and co-editor of the Virchow-Hirsch *Jahresbeiträge*.

As already announced, the seventh International Geographical Congress will be held at Berlin from September 28 to October 4 of this year. The proceedings of the congress, which will include all branches of geographical science, will probably fall under three heads. In the first place, there will be lectures on geographical work and travels during recent years. In this section may be expected, among others, reports upon the results of the German Deep-Sea Expedition still at work, and also upon the geographical and geological investigations of Dr. Futterer in Central Asia. Secondly, there will be discussions concerning the international introduction of a common geographical terminology and of international methods, such, for example, as the general adoption of the metric system, of the centigrade thermometer, and of unity in geographical orthography. Lastly, international efforts will be considered, including the greatest geographical problem of the day, namely, the investigation of the Antarctic regions. The German Government has, at the suggestion of the Geographical Society of Berlin, included a sum of 50,000 marks, as a contribution towards the costs of the congress, in the budget estimates already laid before the "Reichstag." It is expected that the congress, which will this year meet for the first time in the fatherland of Humboldt and Carl Ritter, will have an importance corresponding to the high standard of geographical science in Germany.

THE well-known firm of Merck, in Darmstadt, has sent us the first number of a new periodical called *Merck's Digest*, in which they propose to publish a selection of reports on the physiological action and therapeutic uses of remedies, old and new, prepared by the firm. The firm will forward this regularly, and free of charge, to all medical men or chemists applying to Mr. E. Merck, 16, Jewry Street, London, E.C. So many new remedies are being introduced at present, that it is difficult to become acquainted with even those amongst them which are really useful, and this publication is likely to help medical men and others who desire to keep themselves *au courant* with the progress of pharmacology and therapeutics. We learn with deep regret of the death of Mr. William Merck, the senior partner in the firm, who has done such admirable service to pharmacology by providing pure alkaloids for the use of those who have been engaged in experiments on their physiological action.

THE following particulars with regard to the career of the late Mr. Merck are given in the *Chemist and Druggist*:—After his school training, Merck went to Wiesbaden and studied under Remigius Fresenius. Then in 1854 he went to Breslau to continue his chemical training under Loewig at the University of Breslau, but had to return to Darmstadt owing to the death of his father. Affairs having been settled, he next came to London, entering the Royal College of Chemistry as a student of Prof. A. W. Hofmann, with whom his elder brother George had previously been a pupil. It is interesting to recall the fact that Dr. George Merck was one of the first students of the Royal College who undertook original research, his subject (in which he was associated with Robert Galloway) being an "Analysis of the Water of the Thermal Spring of Bath," which was read before the Chemical Society in December 1846, and was the first of the researches published by the Royal College. Wilhelm Merck remained two seasons in London, then went on to Paris to complete his studies under Wurtz. This magnificent training stood him in good stead in after years Returning to Darmstadt he took his share of the management of the business along with his brothers Karl and George. Mr. Wilhelm Merck took an active interest in the prosperity of his native town, of which he was a councillor for twenty-five years, and to which, as president for a considerable time of the Chamber of Commerce, he rendered important services. Although Mr. Merck was a retiring man, and what he did for Darmstadt was done unostentatiously, the Grand Duke, in 1889, recognised his ability and influence by appointing him Privy Councillor of Commerce, and a life-member of the Upper Chamber of the Grand Duchy. Some time previously he had been decorated with the Grand-Duke Philipp order of the first class.

THE vexed question as the exact meaning of the phrase "one hour after sunset and one hour before sunrise" in the Local Government Act, 1888, referring to the lighting of bicycle lamps, was settled from a legal point of view in a Divisional Court on Thursday last. It had been held that sunset at Greenwich was meant, and the Bristol justices convicted a cyclist for riding a bicycle without a light an hour after sunset thus defined. The alleged offence was committed on August 19, 1898, at 8.15 p.m., which was less than an hour after sunset at Bristol, but more than an hour after sunset at Greenwich. An appeal was made against the decision of the Bristol magistrates; and at Thursday's Court the appeal was allowed, and the conviction quashed, their Lordships holding that the phrase in the Act referred to must not be understood to mean Greenwich time, but local time.

MR. WALTER WELLMAN describes in the *Century Magazine* the journey in the *Frithjof* from Tromso, Norway, to Cape Tegetthoff, Franz-Josef Land—from which place he writes, under date August 2, 1898. As to his plans he remarks:

"During the sixty days which are to pass before the coming of cold and darkness we hope to drag more than a hundred miles to the northward sufficient food and fuel to carry us through the long winter, with the aid of bear meat, while we hibernate, like bears, in a hole in the ground. In February, before the sun shall have returned, if all goes well, we shall set out upon a five-hundred-mile journey back again to the winter lair, and a two-hundred-mile journey after that to reach the ship which is to come out for us next year [1899]."

IN reporting upon the work at the Marine Biological Station at Port Erin during 1898, Prof. W. A. Herdman, F.R.S., points to the necessity for further exploration in the North Atlantic. Attention has repeatedly been drawn of late years to the importance, both from the purely scientific and the industrial points of view, of the problems involved. The Scandinavians (Petterssen, Ekman, Hjort, and others) have succeeded in unravelling some of the interlacing belts of water from Arctic, Baltic, North Sea, and Atlantic sources which sweep past their coast, and affect the movements of migratory fish. It is only by such work that the mysterious movements of the herring—perhaps the most important food fish on our coast—can be rationally explained. Prof. Herdman states that it was formerly supposed that when the herrings left our shores in autumn they retired to the far north, and next season started from the Arctic regions on their annual migration, led by one large old fish—the "King of the Herrings." It is now believed that breeding and feeding are the two impulses that govern the movements of a fish. The herring comes into shallow water on our coast to spawn, and when it migrates in search of food from the Atlantic to the North Sea, or from our west coast out into deep water, there is reason to believe that it is following those minute organisms which form the plankton carried along in particular currents of water, characterised by the temperature, the salinity, and the microscopic fauna. It is possible by these characters to recognise the currents, to trace their variations from year to year, and so to some extent to determine and predict the movements of the shoals of fish. It follows, then, as Prof. Herdman remarks, that one of the most important things the biologist can do to add to our knowledge of life in the sea is to make a survey of the microscopic floating and drifting life of the sea, and its relation on the one hand to the physical conditions at the time (especially the temperature and salinity of the water), and on the other to the food materials found in the stomachs of the fish.

MR. H. C. RUSSELL has sent us an interesting paper on waterspouts, read before the Royal Society of New South Wales in August last. He states that this phenomenon is frequent on the coast of New South Wales, the spouts often occurring in groups of three or four; but on May 16, 1898, an unusual display occurred at Eden. In the early forenoon, during a light north-west wind, with fine weather and smooth sea, a heavy bank of cloud rose above the eastern horizon, and there was a flickering as if electrical discharges were going on between the cloud and sea, but nothing to indicate what was to follow. During the morning there were fourteen clear and distinct waterspouts, reaching from clouds to sea. The process of formation was—a rotary motion of the waves, large quantities of broken water being raised up gradually as a white misty-topped column, the misty part preceding the denser part by 100 to 150 feet. This went on for three or four minutes, during which time the clouds had formed an inverted cone, which seemed to be alternately dipping down and receding, with an interval of about thirty seconds between the dips, until the two cones met, and all the misty matter was absorbed. The column then remained unchanged for some minutes, the overhanging cloud getting denser, and moving slowly until the spout got out of the perpendicular and divided in the middle, the top part rising, while the lower half sank to the ocean. The paper is accompanied by nine plates, showing specimens of waterspouts observed at various times.

THE index number of *The Physical Review* (vol. vii.) contains an account of the determination of the electro-chemical equivalent of silver, recently undertaken by Messrs. Patterson and Guthe, together with a description of the experiments of Messrs. Eddy, Morley, and Miller on the velocity of light in the magnetic field, and a paper by Mr. Ferry on a photometric study of the spectra of mixtures of gases at low pressures. The first article calls attention to the recent work of Kahle, who for a number of years has been engaged at the Imperial Institute at Berlin using Helmholtz's current-balance for investigations on electro-chemical equivalents. Kahle discriminates between "old" and "new" solutions; thus an "old" solution of argentic nitrate is one originally neutral, which has become acid by successive use in voltameters. For a given quantity of electricity, larger deposits are obtained with this than with "fresh" solution; the difference often exceeds one part in one thousand—this must be regarded as a very important observation. Kahle's work is referred to in *Zschr. f. Instrum.*, 17, 144, 1897, and 18, 141, 1898; also August and September 1898. The authors describe their own experiments in which the *e.c.e.* is measured independently of g and H, by balancing the moment due to the electro-dynamic action of the two coils of an absolute electro-dynamometer, against the torsional moment of a wire with very small elastic fatigue.

FOR a long time past the City of Manchester has been in difficulty as to the disposal of its sewage, and at the present time an order obtained by the Mersey and Irwell Board for stopping the pollution of the Ship Canal by the effluent from the existing tanks, carrying a penalty of 50*l.* a day, is only in abeyance pending the result of the works now proposed to be carried out. A scheme for the construction of a culvert to carry the sewage to the estuary of the Mersey, at a cost of 258,000*l.*, was rejected by the ratepayers. It is now proposed to treat the sewage on the septic principle, which has been found successful at Exeter and other places, and to enlist the services of bacteria for the purpose of the sewage disposal; or, as the plan was described at the inquiry of the Local Government Board, recently held, "as the domestication of bacteria for the purposes of sewage disposal." The mineral matter arising from mud detritus is first to be separated by the sewage passing through catch-pits, and it is then to pass over coke-filters, which will cover fifty acres, and in these the "tame microbes" are to be turned on to resolve the impure sewage into water of sufficient purity to be discharged into the Ship Canal. The quantity of sewage to be dealt with is 20,000,000 gallons a day, and this is now treated with chemicals at an annual cost of 17,000*l.* a year, at least half of which is to be saved by the action of the microbes, and it is anticipated that an effluent will be produced that will be satisfactory to the Mersey and Irwell Committee. The Manchester sewage is of an exceptional character, as it contains much trade refuse; but experiments, which have for some time past been conducted by Prof. Frankland, have proved that by means of "double contact beds" the bacteria soon get accustomed to take this sewage, and it has been shown that by this means the whole sewage of the city can be successfully dealt with.

THE international quarterly journal hitherto published under the title *Terrestrial Magnetism* will in future bear the name *Terrestrial Magnetism and Atmospheric Electricity.* With the forthcoming (March) number this periodical, which is devoted exclusively to terrestrial magnetism, and atmospheric electricity—such as earth currents, auroras, &c.—will enter on its fourth

volume. The journal is conducted and published by Dr. L. A. Bauer and Mr. Thomas French, jun., with the assistance of a number of distinguished physicists in various parts of the world. Every issue of the periodical hereafter is to contain at least eight pages of abstracts and reviews, and in every number a half-tone portrait of an eminent magnetician will appear.

A NUMBER of valuable physical papers have been recently published in English in the *Communications* from the Physical Laboratory of the University of Leiden. In the parts now before us, Dr. H. Kamerlingh Onnes describes a hydrogen thermometer for the measurement of low temperatures, and a standard open-tube manometer for high pressures, consisting of sixteen partial manometers connected together in series. Mr. Ch. M. A. Hartman gives the results of observations on the composition and volume of the coexisting vapour and liquid phases of mixtures of methyl-chloride and carbonic acid, and arrives at the result that at the chosen temperature of 9·5° the vapour pressure of the liquid phase of the mixture may be expressed in terms of those of its components, with near approximation, by the formula $p = p_1(1-x) + p_2x$. In another part, Dr. E. van Everdingen, jun., discusses the galvano-magnetic and thermo-magnetic phenomena in bismuth, and criticises Riecke's theory.

PROF. E. VILLARI writes in the *Atti dei Lincei*, vii. 10, on the way in which tubes diminish the electro-dispersive power of Röntgen rays. The experiments all point to the conclusion that the discharge of an electroscope by the action of these rays is due to the air acted on by them. An electroscope placed in the umbra of the rays is discharged by the Röntgenised air which passes into the umbra by diffusion. If between the Crookes' tube and the electroscope there be interposed a tube of glass or zinc, which cuts off the lateral divergent rays, the discharge is greatly retarded, and the same is the case when the ball of the electroscope is enclosed in a tube turned towards the source of the rays, as this prevents the lateral air from reaching the electroscope. When the electroscope is covered by a tube of zinc, so that charges of opposite signs are developed by electrostatic induction on the inside and outside of the tube, the action of Röntgen rays is in the first place to discharge the outside of the tube, and the electroscope falls several degrees; subsequently the electroscope itself is slowly discharged by the Röntgenised air inside the tube. An exactly analogous effect takes place with a tube of paraffin. Under the action of Rontgen rays, or of a flame, the tube becomes oppositely charged to the electroscope, and the latter is afterwards slowly discharged by the Röntgenised air inside the tube. If there be no air between the tube and the electroscope, the initial discharge alone takes place. The present experiments thus afford an explanation of the phenomena observed with tubes and blocks of paraffin, which were described by Lord Kelvin, but left uninterpreted, some time since, in the columns of NATURE.

WE have received a copy of the "Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the year 1896," by F. B. Weeks, published as *Bulletin* No. 149, of the United States Geological Survey. This contains reference to 788 papers, books, maps, &c., with a most excellent classified index. It records works on the geology of the United States, Canada and Mexico, whether published in North America or elsewhere.

THE Cretaceous Foraminifera of New Jersey are described by Mr. R. M. Bagg, jun., in *Bulletin* No. 88 of the United States Geological Survey, 1898. Some of the prominent species, including also several new forms, are illustrated in six plates. The Foraminifera were collected from the Greensand series of the Upper Cretaceous, and Mr. Bagg remarks that he has frequently found the tiny shells filled with glauconite: in other cases the grains of glauconite are internal casts of Cristellariæ, &c. Many of these forms are partially filled with a light brown clay, suggesting the early stage in the formation of the glauconite grain. Mr. Bagg pays a deserved compliment to Mr. C. D. Sherborn, whose "Bibliography of Foraminifera," and "Index to the Genera and Species of Foraminifera," have, by their completeness and accuracy, lightened the labours of all workers on the subject.

WE have received a copy of the second edition of Mr. F. N. Williams's "Provisional and Tentative List of the Orders and Families of British Flowering Plants."

PROF. R. V. WETTSTEIN reprints, from the *Transactions* of the German Association for Natural Science and Medicine of Bohemia, an interesting paper on the various modes of protection of the flowers of geophilous plants—that is, those whose flowers are more or less completely formed beneath the surface of the soil, a class which includes all our very early spring-flowering herbaceous plants.

MR. T. F. MOTT sends us two papers on the origin of organic colour, in which he thus sums up his conclusions:—That the gradual development of organic colour is a physiological necessity; that brilliant coloration is a mark of the maturity of some organic force-wave, in which the molecular rhythm has reached its maximum simplification; and that the effect of insect selection in the development of coloured flowers is comparatively small.

IN a paper in the number of the *Biologisches Centralblatt* for January 1, 1899, Prof. J. Wiesner reviews the state of our knowledge respecting the adaptation of leaves to the intensity of light. He classifies leaves under two heads in this respect—"photometric," or those which assume special positions in order to receive as much light as possible, or to avoid too strong a light; and "aphotometric," those which have no such faculty. The former, again, may be either "euphotometric," when they place themselves in a position to receive the maximum of diffused light; or "panphotometric," when they are adapted to receive both direct and diffused sunlight, but are protected against an excess of the former.

MESSRS. DULAU AND CO. have issued a catalogue of books and papers on general geology which they have for sale.

WITH reference to the appeal for additional work on telegony, referred to last week (p. 301), Mr. G. B. Bulman asks us to say that communications should be addressed to him at Cullercoats, Whitley, R.S.O., Northumberland.

AN illustrated catalogue of physical apparatus, including drawing, surveying, and engineering instruments, balances and weights, and apparatus required in classes under the Department of Science and Art, has been received from Mr. T. M. F. Tamblyn-Watts.

THE following lectures have been arranged to take place at the Royal Victoria Hall, Waterloo Bridge Road, on Tuesdays during February:—February 7, "About some Worms," Prof. Weldon, F.R.S.; February 14, "Some Facts about Liquids," Prof. Holland Crompton; February 21, "India," Mr. R. M. Beachcroft; February 28, "Volcanoes," Prof. H. G. Seeley, F.R.S.

THE osteometric index calculator, referred to by Mr. David Waterston in NATURE of October 20, 1898 (vol. lviii. p. 597), is described and illustrated in the *Journal of Anatomy and Physiology*. The instrument provides a ready means of finding

the cephalic index from two measures of length and breadth of the head.

MESSRS. GINN AND CO. announce the forthcoming publication of "A Laboratory Manual in Astronomy," by Mary E. Byrd. The manual is designed as a handbook of laboratory instruction to accompany the study of elementary and general astronomy in secondary schools and colleges. The same firm announces a college text-book of "Physics," by Profs. Charles S. Hastings and Frederick E. Beach.

THE zoological material collected by Dr. Arthur Willey from New Britain, New Guinea, Loyalty Islands, and elsewhere, during his expedition in search of the eggs of the Pearly Nautilus, is being studied by a number of distinguished zoologists, and the first two parts of a work containing the results have been published by the Cambridge University Press. It is expected that five or six similar parts will be issued; and we defer our notice of the work until all of them have been published.

THE density of liquid air is the subject of an interesting paper by Prof. A. Ladenburg and Dr. C. Krügel, in the current number of the *Berichte*. The hydrostatic method with a Westphal balance was employed. It is pointed out that a determination of the density of liquid air obtained in the usual way is of little value unless accompanied by a determination of the exact composition of the mixture, since, as is well known, after standing some time, the residual fluid is nearly pure oxygen. In these experiments, the whole of the liquid was allowed to evaporate into large gasholders, and the gaseous mixture analysed. From these results, the authors calculated that the density of normal liquid air containing 20·9 per cent. of oxygen would be ·871. It was found that the density of the liquid containing 93·6 per cent. of oxygen was higher than that of pure oxygen. It is suggested that this may be due to carbon dioxide or krypton.

CONSIDERING its exceptional behaviour with respect to hydrogen, the metal palladium has not hitherto been used to the extent that would have been expected as a reducing agent in organic chemistry. The mode of application of palladium, however, described by Dr. N. Zelinsky in the current number of the *Berichte*, would appear to promise a more extensive use of this metal. A zinc-palladium couple is prepared from zinc and palladium chloride, in a manner similar to the well-known zinc-copper couple. This is placed in alcohol, and acid added until hydrogen gas just commences to be evolved. At this stage the palladium black is saturated with hydrogen, and produces energetic reduction of the alkyl iodide or bromide, the acid and iodide being now added alternately. Hexamethylene, and the ethyl and methyl-hexamethylenes, which are obtained with great difficulty from their halogen derivatives by ordinary reducing agents, are produced in yields of 70–75 per cent. of the theoretical, when the corresponding iodides or bromides are treated in this way.

THE additions to the Zoological Society's Gardens during the past week include a Chimpanzee (*Anthropopithecus troglodytes*, ♀) from West Africa, presented by Miss K. M. Burne; a Green Monkey (*Cercopithecus callitrichus*, ♂) from West Africa, presented by Mr. F. W. Coker; a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Miss A. M. Deeks; a Black-headed Lemur (*Lemur brunneus*, ♂) from Madagascar, deposited; a Tui Parrakeet (*Brotogerys tui*) from Brazil, an Uvæan Parrakeet (*Nymphicus uvaensis*) from the Island of Uvea, Loyalty Group, three Common Crowned Pigeons (*Goura coronata*) from New Guinea, purchased; two Barnard's Parrakeets (*Platycercus barnardi*) from South Australia, received in exchange.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN FEBRUARY:—

February 10. 19h. Venus at greatest elongation 46° 46′ west. This planet rises nearly three hours before the sun, and presents a brilliant appearance in the south-east sky.
10. Date of computed perihelion passage of Denning's comet (1881 V.).
11. 10h. 39m. Minimum of Algol (β Persei).
12. 7h. 35m. to 8h. 28m. Occultation of the star 19 Piscium (mag. 5·2) by the moon.
14. Mars. Illuminated portion of disc 0·969.
14. Venus. ,, ,, ,, 0·517.
14. 7h. 28m. Minimum of Algol (β Persei).
15. Jupiter. Polar diameter 35″·8. The planet rises at midnight, and is favourably visible afterwards.
16. 15h. 45m. to 17h. Transit of Jupiter's Sat. III.
18. 8h. 53m. to 10h. 11m. Occultation of the star 103 Tauri (mag. 5·5) by the moon.
24. Saturn. Outer minor axis of the outer ring = 16″·82. Polar diameter 15″. The planet may be well seen as a morning star.

HARVARD COLLEGE OBSERVATORY.—In the fifty-third annual report of this well-known observatory, Prof. Pickering, the director, again chronicles the completion of an enormous amount of work. With the east equatorial (15-inch), under the charge of Mr. O. C. Wendell, about 25,000 photometric light comparisons have been made, chiefly with the new polarising photometer with achromatic prisms. This instrument was also used in the photometric measurement of Jupiter's satellites while undergoing eclipse.

Similar photometric comparisons of variable stars, to the number of about 1650, have been made with the west equatorial (6-inch). These observations are now reduced and will shortly be published. In addition, comparison stars have been selected for sixty other variables, and the co-operation of other astronomers in following up the stars when too faint for the 15-inch is invited, for which purpose charts and lists of the stars in question will be furnished on application.

The reduction of the observations of fundamental stars with the meridian circle, by the late Prof. Rogers, were incomplete at the time of his death, and are still therefore under discussion.

With the meridian photometer the observations have been made by the director. Extending over 152 nights, the number of settings has been 73,684. This completes the work that was planned in 1892 for this instrument, and it is proposed to send it to Arequipa next spring, to revise the contents of the Southern Harvard Photometry.

Photometric observations of faint stars have also been commenced by the director using a 12-inch telescope mounted horizontally, and having a Welsbach burner for artificial comparison.

In connection with the spectroscopic work of the Henry Draper Memorial, 2192 photographs have been taken with the 8-inch telescopes. By the examination of these and other plates taken with the Bruce and Bache telescopes, Mrs. Fleming has detected twelve new variable stars, six of which showed *bright* hydrogen lines; nine stars have spectra of the fourth type, seventeen of the fifth, and ten objects are catalogued as gaseous nebulæ. In three known variables—V Tauri, U Cancri, T Capricorni—the hydrogen lines have been found bright.

With the 11-inch Draper telescope 873 plates have been taken, and a photograph of α Canis Majoris obtained at mid-day under conditions rendering it probable that bright stars could be thus usefully photographed when in transit.

Photographs of stars near the pole have been taken with the 15-inch reflector, with the object of accurately determining the constants of aberration, precession, and nutation.

The examination of the photographs of star clusters for variables has been continued, resulting in the detecting of 509 stars of this type. The most notable occur in the clusters ω Centauri, Messier 3, Messier 5, and Messier 15.

With the Bruce photographic doublet, photographs have been obtained which, with three and four hours' exposure, show no distortion of the star images, and Prof. Turner reports favourably on the freedom from distortion over an area of 4° × 4°. Both chart plates and stellar spectra have been taken with this instrument.

HARVARD ASTROPHYSICAL CONFERENCE.—Several items in the report of this conference have already been noticed, but in the pamphlet now distributed by Prof. M. B. Snyder, of the Philadelphia Observatory, there are some points of interest.

Mrs. Fleming presented a paper on stars of the Vth type in the Magellanic clouds. These stars have spectra consisting chiefly of bright lines, and are usually known as Wolf-Rayet stars. Up to 1897 the number of these objects known was 67, and all lie closely along the central line of the Milky Way. Photographs taken at Arequipa with the Bruce telescope revealed 21 of these objects in the large Magellanic cloud, 3 others in the Milky Way, and 1 in the small Magellanic cloud, bringing the total number up to 92. Of these fifth-type stars 22 are thus in the Magellanic clouds, and this large proportion renders probable the connection of these objects with the Milky Way.

Mr. E. S. King described an ingenious method of converting prismatic spectra into normal spectra. To do this the original plate is inclined to the plate on which the copy is to be made, by an amount calculated to make the scale exact for three points in its length, while at the same time maintaining good focus. As illustrations he showed several stellar spectra compared with Rowland's map of the solar spectrum. Prof. Pickering said that the method was perfectly general, and all scales were thus reproducible.

Mrs. Fleming, in a paper on classification of spectra of variables of long period, describes the characteristics of these objects. About 100 stars of this class are known, and all have the hydogen lines bright. Examination of the relative intensities of these lines has led to the class being divided into eleven groups, of which two are mentioned in detail. One group, represented by R Lyncis, has a spectrum resembling α Tauri, but having $H\beta$ and $H\gamma$ strongly bright, while $H\delta$ is barely visible. Another group, typified by R Leonis, shows a continuous spectrum with $H\beta$ invisible, $H\gamma$ barely visible, and $H\delta$ strongly marked.

Prof. G. E. Hale presented a review of work on the spectra of stars of Secchi's fourth type. These are the blood-red stars, and the spectra of twenty-two of them have been obtained with the spectrograph of the 40-inch Yerkes telescope, mostly with a dispersion of one prism. For the two brightest stars of this class, 132 and 152 Schjellerup, three prisms were employed. The photographs show a large number of lines hitherto unrecorded, most of which are dark; but it is stated that there seem to be a number of bright lines.

The presence of bright lines in 152 Schjellerup was, it is stated, confirmed by Profs. Keeler and Campbell at the Lick Observatory. The wave-lengths of two of the brightest of these lines agree very closely with those of the two brightest lines in the Wolf-Rayet stars, as measured by Campbell; but no connection between these two classes of bodies is yet indicated. A reproduction of the photographed spectrum of 152 Schj. is published in the *Ast. Phys. Journ.*, November 1898.

THE PLAN OF THE EARTH AND ITS CAUSES.[1]

IN a passage in the "Novum Organum" Bacon pointed out resemblances between the continents of the Old and New Worlds, which he thought showed that their shapes were not due to chance, but to the action of a common cause. Similar coincidences have been repeatedly noticed by geographers, who have accordingly been led to the belief that the distribution of land and water on the globe is based on a definite plan. Any such plan can only be recognised in broad outline, since geographical shapes depend on an intricate series of local accidents. Topographical form depends on such inconstant, incalculable factors that the stages of its growth are often untraceable. The missing links of geographical evolution are as numerous as those of organic evolution. Nevertheless, belief in the existence of a fundamental geographical plan is as old as geography. It was expressed in some of the earliest classical maps; it possessed the minds of mediæval cartographers, and led to their fantastic wheel maps; and it was popularised in the first half of the present century by the teaching of Humboldt and Elie de Beaumont. But with the growth of Lyellism and its doctrine of the interchange of land and sea under the influence of local variations in level, the idea fell into discredit.

[1] Abstract of lecture to the Royal Geographical Society on January 23, by Dr. J. W. Gregory.

But the discoveries of oceanography and geology have shown what allowances should be made for the obscuring action of minor oscillations, and thus have revealed fresh geographical homologies and explained apparent exceptions. The introduction of such local changes is, however, unnecessary, since the existence of a geographical plan of the earth is shown by three features: (1) the concentration of land in the northern, and of water in the southern hemisphere; (2) the triangular form of the geographical units, and the southward tapering of the land masses. From these two features it follows that there is a "northern land belt" from which three continents project southward, separated by three oceans, which expand until they form a "southern ocean belt." The third feature is the antipodal position of oceans and continents. The main problem of geomorphogeny is the explanation of these three facts.

The question is simplified by remembering that the earth consists of three parts: (1) the unknown internal centrosphere; (2) the rocky crust, or lithosphere; (3) the oceanic layer, or hydrosphere. Oceans and continents occupy, respectively, depressions and elevations of the lithosphere; and their distribution, therefore, directly depends on the distribution of the irregularities in its surface. If the existing irregularities have remained unchanged throughout geological time, then the problem is astronomical rather than geographical and geological.

The attempts to solve the problem on the basis of the permanence of the main geographical features may be grouped into four sets: (1) Prof. G. H. Darwin has attributed the main geographical lines to tidal wrinkles in the viscous crust; (2) Prinz has assigned them to torsion due to the acceleration of the equatorial and southern belts of the earth, and retardation of the northern land belt; (3) Sir J. Lubbock and Prof. Lapworth have independently explained continental form as due to the intercrossing of two sets of folds, one parallel to the equator and one at right angles to it; (4) Lord Kelvin refers back the main geographical divisions to an even earlier period than the previous theories; for he regards them as due to shoaling in the last molten layer of the globe, over areas determined by previous chemical segregations in the nebula. These theories are not necessarily inconsistent with the asymmetry between the northern and southern hemispheres; the primitive wrinkles, the double folds, and the nebulous segregations are each in harmony with a considerable amount of geological evidence; but the theories are geographically inadequate, because they do not explain how the existing asymmetry has been developed. To do this, some more continuously acting cause is required, such as the secular contraction of the earth, on which Elie de Beaumont based his famous theory. His system, however, regarded the world as symmetrical, and was too rigidly geometrical to apply satisfactorily to a heterogeneous globe. In his "pentagonal réseau" antipodal areas were similar; for he regarded the world as a spheroid based on a pentagonal dodecahedron, which is a holohedral form; whereas, owing to the dissimilarity of antipodes on the earth, the lithosphere may be better regarded as hemihedral. The recognition of this fact led to the great advance on Elie de Beaumont's theory made by Lowthian Green, which has been advocated by de Lapparent and Michel-Lévy.

The tetrahedral theory does not regard the world as a regular tetrahedron; but suggests that, owing to the collapse of the earth's crust due to contraction, the lithosphere has undergone a tetrahedroid deformation. That collapsing shells tend to become tetrahedral, just as short tubes often collapse trigonally, is shown by experiments. "Nothing," says E. D. Preston, "is more in accordance with the action of physical laws than that the earth is contracting in approximately a tetrahedral form. . . . Experiments on iron tubes, on gas bubbles rising in water, and on rubber balloons, all tend to bear out the assumption that a homogeneous sphere tends to contract into a tetrahedron."

If such be the case, then the lithosphere would be depressed on four faces, which, being lower, would be naturally occupied by oceans; while the four projecting coigns would stand up as continents. In such a tetrahedrally deformed earth there would be a central ocean (the Arctic) on one face surrounded by a land belt, from which three meridional continents would run southward; they would each taper to a point, below which would be a southern ocean belt, from which three oceans would project northward. South of the ocean belt would be an Antarctic continent.

The arrangement of land and water on such an ideal, de-

formed globe would be identical with that on the earth; for there would be a northern concentration of land, and a southern excess of water; the geographical shapes—except in the case of the two polar units—would be triangular, and land and water would be antipodal.

The agreement between the facts of geography and the requirements of the tetrahedral theory goes further. The main watersheds and mountain systems—which are by no means coincident—have both a tetrahedral plan, forming a girdle in the northern hemisphere and three approximately equidistant meridional lines in the southern hemisphere.

The first obvious objection to the hypothesis of tetrahedroid deformation of the lithosphere is that physicists having proved the rigidity of the earth, any such deformation is impossible. But the arguments in favour of the earth's rigidity apply to the globe as a whole, and do not debar limited deformation of the crust. Such elasticity is now regarded as demonstrated by the movements of the pole, under such trivial influences as the unequal melting of the polar ice or unbalanced falls of snow. The second objection is that the earth is known to be an oblate spheroid, and therefore is not tetrahedrally deformed. But, owing to the equatorial flattening of the world, it is not a spheroid of revolution; owing to the differences of shape between the northern and southern hemispheres, it is not even an ellipsoid. Herschel pithily stated the facts in his remark that "the earth is earth-shaped"; and Listing's term "geoid" is now generally adopted for the figure of the earth. The geoid is, however, by no means a regular figure; the differences between the astronomical and trigonometrical determinations of positions show that the form is subject to numerous deviations, which cannot at present be attributed to any definite system; for accurate observations have not been made over a sufficiently large portion of the earth. But there are suggestions that, like the physical features of the earth, the major geodetic variations may be on a tetrahedral plan; for there is evidence of great deficiency of gravity in two areas (East Russia and Central U.S.A.), which may represent two of the three minima which should occur in the northern land belt. The ordinary explanation of these deficiencies in gravity—viz. that they are due to vast subterranean blocks of light material—is improbable; because in the Russian case the existence of such blocks is disproved by observations on deviations of the plumb-line (Helmert); and in the American case, Mildenhall has shown that no reasonable, or even possible, assumption will explain the facts. The agreement of gravity observations with Bessel's ellipsoid in Central Europe, and their approximation to Clarke's ellipsoid in Eastern Russia (as shown by Helmert), may indicate that both ellipsoids accurately represent the curvatures of the two areas on which they were mainly based, and that they merge into one another along the line of the East African meridional edge.

Geological evidence gives important support to the tetrahedral hypothesis, for the northern land belt appears founded on three great "schild" (Suess) or "coigns" of Archean blocks: these Scandinavian, Canadian, and Manchurian coigns are 120° apart. The significance of the angular distance between them was first pointed out by De Lapparent in the case of the first two. South of the coigns lines of elevation on the meridional edges would be expected; and, though the geological structure of the country along the three lines differs fundamentally, the three lines of recent or still continuing earth-movements of the Andes, Erythrean rift-valley, and East Australian coast occur in the right positions. That tetrahedral geological symmetry is not only an incident of the present, is shown by the distribution of land and water, and by the arrangement of the mountain system at the end of the Palæozoic; for both were on a tetrahedral symmetry. But in that period the present arrangement was reversed, the land belt being southern and the ocean belt northern in position; the position of the meridional land lines was the same as at present.

Such a change in the areas of tetrahedral flattening would be impossible in a stationary world; but in a revolving globe the collapse, due to contraction, is steadily resisted and confined within narrow limits by the effects of the rotation, which tends to restore the world to the more stable spheroidal form. The great mountain building periods of the earth's history may be due to instability resulting from periods of slow deformation; and the periods of great marine transgressions (*e.g.* the repeated Mesozoic transgressions after the mountain elevations at the close of the Palæozoic) are easily explained as due to the restoration of more regular spheroidal form.

Hence the distribution of land and water on the globe may be regarded as the resultant of two opposing forces, collapse due to secular contraction causing deformations, and the tendency due to the earth's rotation towards the recovery of the spheroidal form. The plan of the earth may be attributed to the continuous foundering of the lithosphere in consequence of the unceasing shrinkage of the centrosphere.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Among the lectures announced for this Term may be noted:—Prof. Burdon-Sanderson on general pathology, Dr. Ritchie on special pathology, Prof. Thomson on cranial nerves and digestive system, Prof. Esson on synthetic geometry of conics and cubics, Prof. Turner on mathematical astronomy, Prof. Miers on physical properties of crystals, Mr. Bowman on microscopical examination of crystals, Prof. Elliott on elliptic functions, Prof. Clifton on electricity, Mr. Walker on physical optics, Mr. Goodrich on aves and mammalia, Mr. Bourne on Ctenophora, Prof. Odling on the sugars, Mr. Watts on organic chemistry, Mr. Veley on physical chemistry, Mr. Marsh on stereo chemistry, Prof. Gotch on physiology of the excitable tissues, Mr. Burch on physiological physics, Prof. Sollas on evolution of the earth and on palæontology, Prof. Tylor on development of culture, Mr. Barclay-Thompson on sauropsidan morphology and palæontology. The other lectures announced are more particularly devoted to the general subjects required for the schools.

Elections will be made in the course of the present term to the Sedleian Professorship of Natural Philosophy, vacant by the death of Prof. Bartholomew Price, and to the Linacre Professorship of Comparative Anatomy, vacant by the resignation of Prof. Ray Lankester.

CAMBRIDGE.—The Duke of Devonshire, Chancellor of Cambridge University, presided on Tuesday over a meeting at Devonshire House to consider the financial needs of the University and the establishment of a Cambridge University Association. A full report of the meeting appeared in yesterday's *Times*. The Chairman set forth the various requirements of the University, in buildings and endowments, to meet the increased demands of the day, and said that altogether something like half a million was needed. He announced that he would contribute 10,000*l*. to the endowment fund. A contribution of 10,000*l*. was promised from Lord Rothchild's firm, and the Drapers' Company intimated their intention of contributing 800*l*. a year for ten years in support of a Professorship of Agriculture. It was resolved to form a Cambridge University Association for the purpose of enlarging the resources of the University.

THE following gifts to educational institutions in the United States are announced in *Science*:—The late Henry Clark Warren, of Boston, an accomplished Oriental scholar, has left to Harvard University a large sum principally for the Sanscrit department, but including 10,000 dollars for the Peabody Museum of American archæology and ethnology, and 10,000 dollars for the Dental School. The same University receives 5000 dollars by the will of the late Susan B. Lyman, Dedham, Mass., and 10,000 dollars by the will of the late Mrs. Mary Ann P. Weld, of Boston, the latter sum being for the purpose of founding a Christopher Minot Weld Scholarship. The Teachers' College of Columbia University has received an anonymous gift of 10,000 dollars.

THE Technical Education Board of the London County Council have arranged to award four scholarships of the value of 150*l*. each, tenable from Easter to Christmas 1899, in some higher commercial school or schools on the continent. Candidates must have had experience in teaching commercial subjects, and must possess a good conversational knowledge of the language of the country in which they proposed to hold these scholarships. The Board's object is to afford to teachers who were well acquainted with some branch or branches of commercial education an opportunity of making themselves acquainted with the organisation and methods of the more successful commercial high schools of the continent. Sir Philip

Magnus has succeeded in arranging for the admission of the Board's scholars to the two principal higher schools of commerce in Paris and to the similar schools in the three Italian towns, Bari, Genoa, and Venice, his suggestions having been most kindly received by M. Bocquet at Paris, and by Signor Fortis, Minister of Industry and Commerce at Rome.

MR. BALFOUR has written a long letter to a constituent in East Manchester on the subject of University education in Ireland. After giving reasons why, in his judgment, the expedient of leaving the one existing teaching University in Ireland—Trinity College—to meet, by a natural process of expansion, the growing educational needs of the country would not be successful, Mr. Balfour suggests that the plan which seems best to solve the University problem, both for the Presbyterians and other Protestants in the north and for Irish Roman Catholics generally, is to establish by a single Act two new teaching Universities—one in Dublin and one in Belfast—on precisely similar lines, and differing in no particular excepting the names of the gentlemen first appointed to serve on their respective governing bodies. As the University in Belfast would absorb the existing Queen's College, the governing body of the new institution should be so constituted as to be a continuation of the old. As the Dublin University is designed to attract those Roman Catholics who now hold aloof from University life altogether, its governing body as first constituted should no doubt, in the main, be of their own way of thinking. A University so constituted would, in Mr Balfour's opinion, meet the need of Roman Catholics, but it would not be a Roman Catholic University, except in the sense that Trinity College and the new University in Belfast would be Protestant, and in that case there would be in Ireland two Protestant Universities to one Roman Catholic.

THE executive council of the County Councils Association passed the following resolutions at a meeting held on January 25: (1) The administrative county (in which term is included the county borough) is *prima facie* to be accepted as the area for secondary education. Nevertheless, provision should be made enabling the council of any county or of any municipal borough to make a representation to the central authority to the effect that it would be desirable, in the best interests of education, that an educational area other than that of the administrative county should be constituted; and if the central authority, after a local inquiry at which all parties interested may be heard, are of opinion that it will be to the best interests of education that such an area should be constituted, they may make an order accordingly. The central authority should be empowered by such order to make such financial adjustments as they may deem equitable and advisable. (2) That the proposal of the Association of School Boards be not approved, and that the executive council, while thinking it desirable that the new local authorities for secondary education in administrative counties should include members of the governing bodies of elementary schools (both board schools and voluntary schools), consider that this will be better secured by a power of co-optation exercised as is recommended in paragraph 36 of the report of the Royal Commission on Secondary Education than by giving any right of separate representation on the new authorities to school boards, which represent parts only of the administrative county.

PROF. S. W. WILLISTON describes in *Science* a remarkable condition of things which exists in Kansas as to the text-books used in the State schools. He says that at the last biennial session of the Legislature of Kansas there was passed what is known as the State uniform text-book law. A commission was appointed whose duty it was to select the text-books of all grades used in the public schools of the State, which were to be furnished at a stipulated price to all pupils. No other text-book than the one selected may be used by any school under pain of severe penalties. The law has now been in force for two years, and these books are being used by several hundred thousand pupils. It appears, however, that specialists or experts are not consulted in the choice of the text-books. Wide latitude was given to the commission, the one important stipulation being that the books should be cheap; and the result is that science manuals are used full of unsound and incorrect statements. The principle of specifying text-books might be a good one if the board which examined the books were wise and representative, and contained a fair proportion of practical teachers; but in Kansas this does not appear to be the case. The School Board of London has a book committee which draws up a list of approved text-books, and a glance at the list is sufficient to show that we need not go to the States for instances of books selected more for cheapness than scientific quality.

SCIENTIFIC SERIALS.

American Journal of Science, January.—The thermodynamic relations of hydrated glass, by C. Barus. During the first or opaque stage of the reaction of hot water on glass at 200° C., volume contraction and increase of compressibility are both marked phenomena. During the second stage the water-glass becomes more and more clear and limpid. Capillary tubes on cooling become rods of brittle water-glass. They always break eventually along their length.—Platinum and iridium in meteoric iron, by J. M. Davison. From 608·6 gr. of Coahuila meteoric iron, 0·014 gr. of metallic platinum were obtained, and 0·0015 gr. of a black powder, which is probably ammonium iridi-chloride. No diamonds were discovered.—Studies in the Cyperaceæ, viii., by T. Holm. This article deals with the root, the rhizome, the aerial stem, and the leaf of some North American species of *Scleria*.—Regnault's calorie, and our knowledge of the specific volumes of steam, by G. P. Starkweather. The writer adduces evidence from Regnault's own experiments to show that his conclusion as to the constancy of the specific heat of water between 0° and 30° is correct. He maintains that all our knowledge concerning the density of steam is limited to the saturation line, the experiments on superheated steam presenting discrepancies which cannot be reconciled.—The estimation of boric acid, by F. A. Gooch and L. C. Jones. The salts are treated with sulphuric acid, and the boric acid is distilled with methyl alcohol, and the distillate evaporated over calcium oxide. In searching for a less hygroscopic material to replace the calcium oxide as a retainer for boric acid, the authors found that sodium tungstate, fused with a slight excess of tungstic acid over that contained in the normal tungstate, answers the purpose excellently.—New Actinians, by A. E. Verrill. Describes a number of new families and genera from Hong Kong, Guadeloupe, Panama, Peru, and San Salvador.—What is the Loess? by F. W. Sardeson. The Loess loam, in combination with land and fresh-water shells, forms a very strong argument in favour of the purely æolian origin of the Loess.—Absorption of gases in a high vacuum, by C. C. Hutchins. The vacuum of Röntgen ray tubes is increased by successive discharges, until it becomes too high for any discharge to pass. This can be prevented by putting some mercuric oxide in a side tube surrounded by a platinum wire heated by a shunt. If a suitable spark gap is inserted in the shunt, the heating may be made automatic. The oxide gives off oxygen when heated, which lowers the vacuum to a proper amount.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, January 27.—Mr. G. Griffith, Vice-President, in the chair.—A mathematical paper was read by Dr. E. H. Barton on the equivalent resistance and inductance of a wire to an oscillatory discharge. Maxwell's treatment of the self-induction of cylindrical conductors was extended by Lord Rayleigh, in an article published in the *Phil. Mag.* for May 1886, to alternate currents that follow the harmonic law at constant amplitude. Dr. Barton now modifies the analysis, and further extends it to include the decaying periodic currents obtained in discharging a condenser, and to the case of damped trains of high-frequency, *i.e.* to Hertz waves in general. The theoretical value (R''/R') for the ratio of equivalent resistances to waves, respectively with and without damping, agrees very well with Dr. Barton's experimental results.—Mr. Oliver Heaviside, in a communication (here abstracted), said that he had by another method of mathematical analysis arrived at the same value as Dr. Barton for (R''/R'). In addition to the causes hitherto suggested as affecting the attenuation factor, it was possible that the conductivity of the wires to vibrations millions per second, might be less than with steady currents, and that the voltage at the beginning of the wave-train might be large

enough to cause some leakage. Both resistance and inductance become infinite with infinite damping, and they differ somewhat from the corresponding quantities for undamped waves.—Mr. Rollo Appleyard then described (1) some experiments upon dephlegmators, in which he has attempted to replace the platinum-gauze valves of the ordinary fractionating-tubes by bends in the tubes. The general form of the apparatus consists in a series of elongated bulbs, the top of each being connected to the bottom of the one above it by a horizontal S-shaped tube. The vapour condensed in any intermediate bulb falls back into the preceding S-bend. The first portions of the distillate are thus returned to the boiling-flask, leaving a little at each bend to act as a wash for the ascending vapour. At the early stage of distillation the bulbs and bends behave as required, but it is found that at the later stages certain of the bulbs become completely filled with liquid sustained by the upward pressure of the vapour, and unless the heating is very carefully managed "Geyser" actions may take place. Some arrangement of overflow tubes is therefore required for the bulbs. Mr. Appleyard also exhibited (2) a temperature tell-tale, to be used in connection with vats and for other purposes where an alarm is to be sounded by making electric contact when temperature rises or falls beyond certain limits. A J-shaped glass tube has its short limb sealed and its long limb open. Water or other suitable liquid is poured in, completely filling the short limb. Mercury is then made to displace nearly all the water in the short limb; the surplus water in the long limb is removed by a pipette, and the mercury is adjusted to a convenient level. Two platinum contact-wires are sealed into the glass at a short distance above the free surface of mercury in the long limb. The tube may be half an inch in diameter, with a long limb of 5 inches, and a short limb of 2½ inches. The quantity of mercury in the tube is generally arranged so that at temperatures below the boiling-point of the contained liquid, the mercury level is lowest in the long limb. In this case, if the temperature is raised to the boiling-point of the contained liquid, the mercury assumes approximately a common level in both limbs, for at the boiling-point of the liquid, under these conditions, the vapour-pressure is equal to the barometric pressure. Hence, the liquid and the mercury are not spurted out. Mr. Whopple said that when working with an ordinary "thermometer" tube, the contacts were inefficient owing to oxidation. Moreover the mercury column broke up, and in some cases mercury clung to the contact-wire. He asked if these difficulties occurred in Mr. Appleyard's apparatus. Mr. Watson suggested that in some cases the long limb might with advantage be closed. With regard to the dephlegmator he thought that the bends should each be duplicated by a short tube, so as to provide one path for the descending liquid and another for the ascending vapours. This seemed to be the object of the platinum gauze in fractionating-tubes. Mr. Appleyard, in reply, explained that the change of level in the "tell-tale" was a sudden rise of about an inch of mercury, in a tube half an inch in diameter. This rise was able completely to envelope the contact wires, surface oxidation could not affect the working, and there could be no such thing as failure of contact. Moreover, the tube was too wide for mercury to be held up by capillarity. The large area of contact enabled the instrument to be used for strong currents. The cost was small, and the only adjustment consisted in choosing a liquid of suitable boiling-point; for the platinum wires could be sealed in anywhere in the long limb; about two and a half inches from the bottom was a good position for them. The sudden rise occurred when the temperature was one or two degrees above the boiling-point of the contained liquid.—Mr. T. H. Littlewood then read a paper on the volume-changes which accompany solution, and described an apparatus for measuring the contraction observed when solids are dissolved in a liquid. Two glass bulbs are arranged one above the other, so that liquid can pass from the upper one to the lower one through a stop-cock, and from the lower one upwards into the neck of the upper one through a second stop-cock. This neck, which forms the top of the upper bulb, is fitted with an india-rubber stopper. The lower bulb is tubulured, and provided with a glass stopper. A horizontal capillary tube is fitted into the india-rubber stopper, so that volume changes can be determined, after the manner of using Bunsen's calorimeter. The weighed solid is introduced at the tubulure. The measured amount of water is poured in at the neck. Paraffin oil is now poured in at the tubulure so that the apparatus is completely filled: the lower bulb with the solid and the oil, the upper bulb with the water. The apparatus is then exhausted, and finally it is placed in a tank of water at constant temperature. When the stop-cock between the bulbs is opened, solution begins, and the resulting contraction is measured. For small amounts of salt dissolved in constant volume of liquid, the contraction is very nearly proportional to the amount of salt. For larger amounts, the contraction is greater in proportion than the added salt. If a strong solution is gradually diluted, then for equal amounts of water added, the contraction becomes smaller for successive amounts of added water. Mr. Littlewood applies Ostwald's theory, and the theory of Van der Waals to the observed results, and expresses the contraction as a logarithmic function of the volumes and the internal pressures. Mr. Lehfeldt thought the india-rubber stopper was a weak point in the apparatus. With regard to the theory of the contraction, Tammann (*Zeitschr. für Phys. u. Chem.*, 1895), had given an expression which was rather more intelligible. Tammann found that the effect could be regarded as equivalent to a change of pressure, and by attributing this quality to the solution, the characteristic surface becomes the same as that for water. The volume of the solution would thus follow similar changes to those that water undergoes with increasing pressures. Prof. Ewing said the experiments reminded him of the very first piece of research work he had done in physics, which was twenty-five years ago, on the same problem, with Mr. McGregor. An examination of the electrical properties of solutions of certain salts led to an investigation of their changes of density and volume. In some cases the contraction observed was so great that the volume of the solution was less than the original volume of the water to which the salt had been added. They made some measurements, but the apparatus they had used was very rough compared to that described by Mr. Littlewood. Mr. Watson asked whether Mr. Littlewood had made any simultaneous density measurements. There were some solutions for which the contractions and corresponding densities had been worked out. By examining successive dilutions of strong solutions, and the corresponding densities, a check might be made as to the numerical results obtained by Mr. Littlewood's apparatus. Dr. Chree suggested that in place of the logarithmic expression, the total contraction might possibly be better represented by a few terms of a series involving increasing powers of the difference of volume, each term being multiplied by a proper constant. Mr. Littlewood, in reply, said that the india-rubber stopper possessed advantages in regulating the height of the capillary tube. It did not introduce sensible error, for it was possible to work with it to a centigram of mercury in the capillary. On the other hand temperature-changes of one-tenth of a degree involved one centigram more or less of mercury in the tube. Bunsen, using an india-rubber stopper, obtained very accurate results in calorimetry.

Zoological Society, January 17.—Dr. Albert Günther, F.R.S., Vice-President, in the chair.—Dr. F. P. Moreno exhibited and made remarks upon the original specimen of the recently-described Mammal *Neomylodon listai*, which he believed to be a portion of the skin of one of the old Pampean Mylodons now quite extinct.—Mr. Sclater read some extracts from letters recently received from Mr. J. S. Budgett, who had been sent by the Council on a scientific mission to the Gambia.—Mr. Alfred H. Cocks, exhibited some living specimens of supposed hybrids between the stoat ♂ and ferret ♀.—Mr. R. E. Holding exhibited and made remarks upon some deformed antlers of a fallow deer and of an axis deer. The abnormality in the former was thought to be due to imperfect formation of the "burr," and that of the latter to continued bad health.—Mr. G. E. H. Barrett-Hamilton exhibited some skins of continental squirrels which showed remarkable seasonal changes in coloration, and pointed out their differences from British specimens.—Dr. Arthur Willey gave an account of his itinerary, in the years 1894 to 1897, while in search of the eggs of the pearly nautilus. His travels took him to New Britain, New Hanover, New Guinea, Sydney, New Caledonia, the Loyalty Islands, and elsewhere. In addition to results connected with the main object of the journey, the author described a number of collateral results which were of special interest. These related largely to animals which occupy a low position in the scale of the animal kingdom, and represent vestiges of what were in all probability predominant

types in former ages, such as *Balanoglossus*, *Amphioxus*, and *Peripatus* These creatures were of great interest in respect of their geographical distribution, a subject which was dealt with in the paper. The paper was illustrated by lantern slides portraying some of the author's captures and the methods employed in procuring his material.—Prof. D'Arcy Wentworth Thompson, C.B., read a communication on characteristic points in the cranial osteology of the parrots. The orbital ring, the auditory region, the quadrate bone, and other minor characters were described in about forty genera. *Stringops*, in regard especially to its quadrate bone, seemed to be the most primitive form. *Nestor* was in several respects still more divergent from the rest, though its divergent characters were not necessarily primitive.—A communication was read from Miss Isa L. Hiles, containing a report on the Gorgonacean corals collected by Mr. J. Stanley Gardiner on Funafuti. The collection contained specimens of two new species, viz. *Acamptogorgia spinosa* and *Villegorgia rubra*, and of other species, some of which were of interest as having been described previously only from localities far removed geographically from Funafuti.—A communication was read from Mr. Arthur E. Shipley, containing notes on a collection of Gephyrean worms obtained on Christmas Island by Mr. C. W. Andrews. One species of Echiuroid and five of Sipunculoid worms were treated of in this paper.—A communication was read from Mr. James Yate Johnson, containing notes on the *Coralliidae* of Madeira, and descriptions of two new species, viz. *Pleurocorallium tricolor* and *P. maderense*.

Royal Meteorological Society, January 18.—Mr. F. C. Bayard, President, in the chair.—The Council in their report stated that, owing to the premises now occupied by the Society at 22 Great George Street, being required by the Government, they had been obliged to seek accommodation elsewhere, but not being able to secure offices in the immediate neighbourhood, they had taken a suite of rooms at 70 Victoria Street.—Mr. Bayard, in his presidential address, gave an account of the government meteorological organisations in various parts of the world. He first briefly described the founding of each system, and mentioned the names of the various directors, and then enumerated the number of observing stations associated with each organisation. In most countries forecasts of the weather are issued, and Mr. Bayard gave some interesting particulars as to the success attained by each office. The amount of money voted by the various governments for the support of meteorology showed what a very small portion of the revenue of the different countries goes towards the promotion of this science. In the British Isles it is two shillings and sixpence per square mile, but only about one-third of a farthing per head. The address was illustrated by a large number of lantern slides showing views of the various observatories and portraits of the directors. Mr. Bayard was re-elected president for the ensuing year.

Royal Microscopical Society, January 18.—Annual Meeting.—Mr. E. M. Nelson, President, in the chair.—After the report of the Council for the past year and the Treasurer's statement of accounts had been read and adopted, the President announced that the following were elected as officers and Council for the ensuing year:—President: E. M. Nelson. Vice-Presidents: A. W. Bennett, G. C. Karop, the Hon. Sir Ford North, J. J. Vezey. Treasurer: W. T. Suffolk. Secretaries: Rev. Dr. W. H. Dallinger, Dr. R. G. Hebb. Ordinary Members of Council: J. M. Allen, C. Beck, Dr. R. Braithwaite, Rev. E. Carr, W. Carruthers, T. Comber, E. Dadswell, A. D. Michael, T. H. Powell, C. F. Rousselet, Dr. J. Tatham, Rev. A. G. Warner. Curator: C. F. Rousselet.—The President then delivered the annual address; the first portion was a review of the work of the past year, in the course of which he congratulated the Society on its improved position, the second portion was a paper on dispersion, in which he discussed some formulæ necessary in constructing achromatic lenses; diagrams and tables in illustration of the subject being thrown upon the screen.

Chemical Society, January 19.—Prof. Dewar, President, in the chair.—The following papers were read:—Researches on moorland waters (1), by W. Ackroyd. The author distinguishes between organic and inorganic acidity in moorland waters; their amounts are determined by (1) titration with N/100 alkali, and (2) titration in a sample freed from carbon dioxide by aspiration of air.—Esterification constants of substituted acetic acids, by J. J. Sudborough and L. L. Lloyd. From the authors' experiments it appears that the rate of esterification of an acid depends on the constitution of the acid rather than its strength.—Diortho-substituted benzoic acids. Part iv. Formation of salts from diortho-substituted benzoic acids and different organic bases, by L. L. Lloyd and J. J. Sudborough. The authors are attempting to determine whether the capacity to form salts is dependent on (1) the strength of the acid and of the base, or (2) the constitution of the acid and of the base or on both of these.—α-Ketotetrahydronaphthalene, by F. S. Kipping and A. Hill. Under suitable conditions phenylbutyric chloride is converted by aluminium chloride into α-ketotetrahydronaphthalene by intermolecular condensation.—A new method for preparing unsymmetrical dimethyl- and trimethyl-succinic acids, by W. A. Bone. Ethylic sodiocyanoacetate when heated with alcoholic ethylic α-bromoisobutyrate yields unsymmetrical ethylic dimethylcyanosuccinate $(CO_2Et)CH(CN).CMe_2.CO_2Et$, which on hydrolysis yields the corresponding dimethylsuccinic acid; the sodio-derivative of the dimethylcyanosuccinate yields ethylic trimethylcyanosuccinate with methylic iodide.—Production of optically active mono- and di-alkyloxysuccinic acids from malic and tartaric acids, by T. Purdie and W. Pitkeathly. Alkylation by means of alkylic iodides and silver oxide is generally applicable to the ethereal salts of hydroxy-acids. As racemation does not occur in the process, it is specially adapted for the preparation of optically active compounds.—The action of ammonia on ethereal salts of organic acids, by S. Ruhemann. Ethylic phenylpropenetricarboxylate when treated with ammonia yields ethylic γ-phenyl-$\alpha\alpha'$-dihydroxy-β-carboxylate and phenyl-dihydroxypyridine; similarly ethylic phenylbenzylglutaconate yields γ-phenyl-β-benzyl-$\alpha\alpha'$-dihydroxypyridine.—The changes of volume due to dilution of aqueous solutions, by E. B. H. Wade.—The thermal effects of dilution, by J. H. Pollok.—Halogen derivatives of acetonedicarboxylic acid; Part i., by F. W. Dootson. Ethylic acetonedicarboxylate is converted by dry chlorine into ethylic tetrachloracetonedicarboxylate.—The detection and determination of sucrose in the presence of lactose, by E. Dowzard. The author determines sucrose in presence of lactose by taking advantage of the fact that sucrose is inverted by citric acid whilst lactose is not.—Note on the interaction of formaldehyde with β-naphthylamine derivatives, by G. T. Morgan.

Geological Society, January 18.—W. Whitaker, F.R.S., President, in the chair.—On a small section of felsitic lavas and tuffs near Conway (North Wales), by Frank Rutley. The rocks described in this communication were collected in 1877, in series, at short intervals, from a point at the mouth of the river Conway, near Bodlondeb. They consist of felsitic lavas and tuffs, sometimes nodular, and generally exhibiting some variety of fluxion-structure, corrugated, or banded. A specimen showing brown bands is compared with one described by Iddings from the Yellowstone Park. What were once possibly red bands are now represented by devitrified brown glass, and the change in colour may have been due to the action of water upon the ferric oxide which originally gave its colour to the glass. Some of the rhyolites are tufaceous, and envelop fragments of rocks, some of which were originally vitreous, others lithoidal. Coarser rhyolitic tuff occurs at the northern end of the series.—The geology of Southern Morocco and the Atlas Mountains, by the late Joseph Thomson. This paper gives the results of observations made under considerable difficulties during a journey in Morocco in 1888. The tract traversed is roughly triangular, the base being the Atlantic Ocean between Saffi and Agadir, and the apex the district of Demnat, on the northern slopes of the Atlas, some sixty miles east of the city of Morocco. This district consists of three main sections: (1) The coast lowlands; (2) the plateau in two chief steps, the northern rising to 2000 and the southern to 5000 feet; (3) the Atlas itself, which only begins to be a mountain-chain about thirty miles from the coast, and which ranges first east-by-north and then north-east in its central and loftiest part. (1) The lowlands are practically conterminous with the Tertiary deposits, among which apparently Eocene, Miocene, and Pliocene rocks are represented. The latter consist of shelly sands 200 to 300 feet thick, gradually rising to a height of 700 feet south and east of Saffi. Their surface is often covered with the slaggy tufaceous crust described by Maw. (2) The plateau is underlain by three rock-formations: (*a*) Metamorphic rocks, including clay-slates, which probably underlie the whole Plain of Morocco, and rise into a group of rugged hills called the "Jebelet," in contradistinction to the "Jebel," or Atlas proper. (*b*) The Lower Cretaceous rocks, consisting of red shales and sandstones, the

former frequently giving rise to brine springs and containing salt deposits at Demnat in the Atlas. (*c*) The Upper Cretaceous rocks, chiefly white and cream-coloured limestones, which attain their greatest development on the plateau. (3) The Atlas itself is made up for the most part of the same rocks. There is a core of metamorphic rocks, which is better developed and wider at the western end of the range and narrower towards the east. Next comes the great development of the Lower Cretaceous strata, followed by a diminutive representative of the Upper Cretaceous rocks. These rocks are much broken by folding and faulting, and their structure is displayed in several sections taken across the range from Demnat westward. The first signs of glacial action were met with at Titula, consisting of moraine-like heaps of débris; elsewhere, scratched stones were found.

DUBLIN.

Royal Dublin Society, December 21, 1898.—Prof. T. Preston, F.R.S., in the chair.—Mr. J. E. Duerden, of Kingston, Jamaica, communicated a paper giving an anatomical description of ten species (seven Stichodacylinæ and three Zoantheæ) of Jamaican Actiniaria. A new genus, *Heliktanthus*, is erected for the *Actinia anemone* of Ellis, and included along with the genera *Ricordea* and *Actinoporus*, under the family Discosomidæ. Three species of *Parazoanthus* are all new.—Prof. T. Johnson gave an account of the different kinds of peat and their products, including a set of continental specimens recently added to the Botanical Department of the Science and Art Museum, Dublin.—Prof. James Lyon presented a note on the reversal of the photographic image, with lantern illustrations.—Dr. Gerald Molloy read a paper on the use of the vertical wire in Mr. Marconi's system of signalling through space, by means of electric waves. Mr. Marconi had found that by using a long vertical wire in connection with the oscillator at the sending station, and a similar wire in connection with the resonator at the receiving station, he was able to increase the distance over which intelligible signals could be sent, from a few hundred yards to fourteen miles and more. But the curious thing was that the wire was quite ineffective if placed horizontally. To account for this, Dr. Molloy proposed a theory, founded on the principle of electric images. He showed that, whether the wire was placed horizontally or vertically, the oscillations of the discharge were accompanied by oscillations of the electric image, and that each set of oscillations sent out waves into space. But there was this difference between the two cases: when the wire was horizontal, the waves sent out by the oscillations of the image were in opposite phase to those sent out by the oscillations of the discharge, and therefore tended to extinguish them; whereas when the wire was vertical, the two sets of oscillations were in the same phase, and tended to reinforce each other.—Mr. Ernest A. W. Henley presented a preliminary note of a method of measuring the relative opacities of various organic substances to the X-rays. He found the numbers representing the relative opacities of bone, muscle, and fat to be 4, 2·5, and 1. These results were obtained by comparing X-ray photographs of wedge-shaped pieces of the substances placed side by side, and finding two points, one in each wedge, which had the same depth of colour. The thickness of each wedge at the point found in it was measured, and hence the ratio of the opacities was determined.—Prof. G. F. Fitzgerald, F.R.S., read a paper on a hydrodynamical hypothesis as to electromagnetic actions The paper is an attempt to extend Lord Kelvin's papers on the propagation of laminar motion in a turbulent liquid in the *Phil. Mag.*, 1887, vol. xxiv. p. 342, and which he there illustrated by separate vortex rings in the case of long vortex filaments, such as Lord Kelvin described in a paper on vortex filaments surrounded by a tore (*R. I. Acad. Proc.*, ser. iii., 1889, vol. i. p. 340). It appears as if electric force should be represented by a helical condition of the filaments, which would be propagated with another accompanying motion which represents magnetic force. An electron should then be the irregular point where two helices wound in opposite directions meet.

PARIS.

Academy of Sciences, January 23.—M. van Tieghem in the chair.—Some remarks on the prolongation of functions, by M. Emile Picard.—On some properties of aluminium, by M. A. Ditte. The results of experiments on the corrosion of aluminium by saline solutions show that the metal is at first vigorously attacked, but that a coherent protective layer of alumina is soon formed. In presence of air, however, the corrosion goes on, and if an aluminium plate has been immersed in a salt solution and then only imperfectly washed, the attack slowly continues, the surface becoming more easily attacked by other reagents.—Histology of the skin. Some histo-chemical reaction of eleidine, by M. L. Ranvier. The fragment of skin is left for ten hours in a ten per cent. solution of common salt, then hardened in alcohol, and the sections stained with picrocarmine. A uniform red tint is observed at the level of the *stratum granulosum*, the granules of eleidine being completely diffused. In this way it can be shown that the epidermal cells lose their granular eleidine sharply in passing from the *stratum granulosum* into the *stratum intermedium*.—On the formation of pollen and the chromatic reduction in *Naïs major*, by M. L. Guignard. The numerical reduction appears only at the instant when the pollen mother-cell commences to divide up into the four pollen grains. During the first division of the mother-cell, each chromosome splits twice longitudinally and becomes quadruple; during the second division, the our chromosomes already formed are simply distributed equally between the four pollen nuclei.—Researches on the chemical state of the elements contained in steels. Double carbides of iron and other metals, by MM. Ad. Carnot and Goutal. The carbides $Fe_3C.WC.$, $Fe_3C.Mo_2C$, $2Fe_3C.Mn_3C$, $Fe_3C.2Mn_3C$, and $Fe_3C.4Mn_3C$ were isolated from steels containing tungsten, molybdenum, and manganese. — The first voyage of the *Princess Alice II.*, by Prince Albert I. of Monaco. A *résumé* of the scientific results of the voyage in the polar seas during the summer of 1898. The majority of the specimens were collected in the northern Norwegian fjords and at Spitsbergen.—Prof. Mendelejeff was elected correspondant in the Section of Chemistry, in the place of the late Prof. Kékulé.—Observation of the total eclipse of the moon of December 27, 1898, made at the Observatory of Besançon, by M. L. J. Gruey.—Observations of the planet 1898 ED (Charlois), and of the Chase comet, made at the Observatory of Besançon, by M. P. Chofardet, by M. L. J. Gruey.—On some photographs of nebulæ and star clusters, obtained at the Observatory of Meudon, by M. Louis Rabourdin. The paper is accompanied by seven reproductions of photographs of nebulæ and of the great Hercules star cluster.—Generalisation of Jacobi's first method of integrating partial differential equations, by M. N. Saltykow.—On groups of operations, by M. G. A. Miller.—On the development of certain surds in continued fractions, by M. Crelier.—On the deformation of some quadrics of revolution, by M. C. Guichard.—On the normal equation of surfaces, by M. A. Pellet.—On the expression of the energy of a circuit and the law of the electromagnet, by M. A. Perot.—On the chemical action of the X-rays, by M. P. Villard.—Action of oxidising agents on some aromatic compounds, by MM. Œchsner de Coninck and A. Combe. A continuation of work previously described. Nitrogen gas was evolved on oxidation with chromic acid in only one case, that of picramic acid.—Action of iodine monochloride upon monochlorobenzene in presence of anhydrous aluminium chloride, by M. A. Mouneyrat. Iodine monochloride acts readily upon chlorobenzene in presence of aluminium chloride at 60° C. The main product of the reaction is *p*-iodochlorobenzene, small quantities of dichlorobenzene and trichlorobenzene being obtained as bye-products.—Studies in filtration; organic liquids, by M. J. Hausser. The filtering layer in these experiments was composed either of kaolin, calcium phosphate, or animal charcoal. The filtering layer was not changed by the successive passage of different liquids. The relative velocities of filtration for a given liquid are not altered by a change in the filtering material.—Biochemical oxidation of propane glycol, by M. André Kling. Propane glycol is oxidised by the sorbose bacteria to either acetol or pyruvic aldehyde, the osazone of which was isolated.—On some cellular bodies in the organism of a vertebrate, by M. P. Stephan.—Researches on the anal glands of the *Carabidae*, by M. L. Bordas.—On the mechanism of flight in insects, by M. Charles Janet.—Relations between the intensity of the green coloration of leaves and assimilation by chlorophyll, by M. Ed. Griffon. It is not always possible to predict the intensity of chlorophyllian assimilation by the intensity of the green coloration in fully-developed leaves. In some cases leaves having the same tint have different assimilating powers, and in others the pale leaves may assimilate more strongly than the darker leaves.—On the primordial leaves in *Cupressus*, by M. Aug. Daguillon.—On the structure of the bundles of the placenta in the genus *Primula*, by M. E. Decrock.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 2.

ROYAL SOCIETY, at 4.30.—Sets of Operations in relation to Groups of Finite Order: A. N. Whitehead.—Note on the Enhanced Lines in the Spectrum of α Cygni: Sir J. N. Lockyer, F.R.S.—The Constitution of the Electric Spark: Prof. A. Schuster, F.R.S., and G. Hemsalech.—On the Effects of Strain on the Thermo-electric Qualities of Metals: Dr. Magnus Maclean.

ROYAL INSTITUTION, at 3.—Tibet and the Tibetans: A. H. Savage Landor.

LINNEAN SOCIETY, at 8.—Notes on the Genus Nanomitrium, Lindberg: E. Stanley Salmon.—On the Production of Apospory by Environment in *Athyrium Filix-foemina*, var. *unco-glomeratum*, an apparently Barren Fern: Dr. F. W. Stansfield.—On the Genus Lemnalia, Gray, with an Account of the Branching System of the Order Alcyonacea: Gilbert C. Bourne.

CHEMICAL SOCIETY, at 8.—(1) Maltodextrin, its Oxidation Products and Constitution; (2) On Attempts to prepare Pure Starch Derivatives through their Nitrates: Dr. H. T. Brown, F.R.S., and J. H. Millar.—An Isomeride of Amarine: Dr. H. Lloyd Snape and Dr. Arthur Brooke.—Propylbenzenesulphonic Acids: Dr. G. T. Moody.—Derivatives of Dibenzylmesitylene: W. H. Mills and T. H. Easterfield.—On the Action of Chlorosulphonic Acid on the Paraffins and other Hydrocarbons: Dr. Sydney Young, F.R.S.—(1) The Action of Reducing Agents on Nitrogen Iodide; (2) The Action of Acids upon Nitrogen Iodide: F. D. Chattaway and H. P. Stevens.—The Composition of Nitrogen Iodide: F. D. Chattaway.—(1) The Preparation and Properties of Nitrogen Iodide; (2) The Action of Light upon Nitrogen Iodide; (3) The Action of Alkaline Hydrates, of Water, and of Hydrogen Peroxide upon Nitrogen Iodide; (4) Theory of the Formation and Reactions of Nitrogen Iodide: F. D. Chattaway and Kennedy J. P. Orton.

FRIDAY, FEBRUARY 3.

ROYAL INSTITUTION, at 9.—The Roman Defences of South-East Britain: Prof. Victor Horsley, F.R.S.

GEOLOGISTS' ASSOCIATION, at 7.30.—Annual Meeting.—Address by the President, J. J. H. Teall, F.R.S.

QUEKETT MICROSCOPICAL CLUB, at 8.

MONDAY, FEBRUARY 6.

SOCIETY OF ARTS, at 8.—Bacterial Purification of Sewage: Dr. Samuel Rideal.

IMPERIAL INSTITUTE, at 8.30.—Explorations in Fiordland, New Zealand: Hon. Thomas Mackenzie.

VICTORIA INSTITUTE, at 4.30.—Protection among Animals: Dr. W. Kidd.

TUESDAY, FEBRUARY 7.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—On the Cerebral Convolutions of the Gorilla: F. E. Beddard, F.R.S.—Note on the Presence of Supernumerary Bones occupying the place of Prefrontals in the Skull of certain Mammals: Dr. R. O. Cunningham.—On the Mice of St. Kilda: G. E. H. Barrett-Hamilton.—Notes on *Notornis*: Prof. W. Blaxland Benham.

RÖNTGEN SOCIETY, at 8.—A Modified Form of Toepler Mercury Pump: Wilson Noble.—Discussion on the Röntgen Ray Photography of Soft Tissues, introduced by the President.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Paper to be read and discussed: The Waterworks of the Madras Presidency: J. A. Jones. And, time permitting: The Lake Superior Iron Ore Mines, and their Influence upon the Production of Pig Iron and Steel: Jeremiah Head and Archibald P. Head.

WEDNESDAY, FEBRUARY 8.

SOCIETY OF ARTS, at [illegible].—Nernst's Electric Light: James Swinburne.

THURSDAY, FEBRUARY 9.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On the Reflection of Cathode Rays: A. A. C. Swinton.—On the Recovery of Iron from Overstrain: James Muir.—A Soil Bacillus of the Type of De Bary's *B. megatherium*: Dr. W. C. Sturgis.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

MATHEMATICAL SOCIETY, at 8.—On a certain Mineral Surface and on a S[illegible]tion of $\nabla^2 V$ [illegible]: T. J. Bromwich.—The Group of Linear Homogeneous Substitutions on pq Variables which is defined by a certain Invariant: Dr. L. E. Dickson.—On the Complete System of Differential Covariants of a Single Pfaffian Expression, and of a Set of Pfaffian Expressions: J. Brill.—Groups of Order p^3q: E. A. Western.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains: J. Pigg.—The Regulation of Wiring Rules: C. H. Wordingham. The Institution Wiring Rules: R. E. Crompton.—(Continuation of Discussion, if time permits: Electric Traction by Surface Contacts: Miles Walker.

FRIDAY, FEBRUARY 10.

ROYAL INSTITUTION, at [illegible].—Motion of a Perfect Fluid: Prof. H. S. Hele-Shaw.

ROYAL ASTRONOMICAL SOCIETY, at [illegible].—Anniversary Meeting.

PHYSICAL SOCIETY, at 5.—Annual General Meeting.—Address by the President.—An Ampere-Meter and a Volt-Meter with a Long Scale: Benjamin Davies. (This will probably be read by Dr. Lodge.)

MALACOLOGICAL SOCIETY, at 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Electrical Driving of Engineering Workshops: William Middleton.

SATURDAY, FEBRUARY 11.

ROYAL INSTITUTION, at [illegible].—Mechanical Properties of Bodies: Lord R[illegible]gh.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Sanatoria for Consumptives: Dr. F. R. Walters (Sonnenschein).—L'Industrie du Goudron de Houille: Dr. G. F. Jaubert (Paris, Gauthier-Villars).—The Tōkyō Imperial University Calendar, 1897-98 (Tōkyō).—Die Spiele der Menschen: Prof. K. Groos (Jena, Fischer).—Photography: A. Brothers, 2nd edition (Griffin).—A Text-Book of Physics: Profs. Poynting and Thomson, Sound (Griffin).—Dictionary of Medical Terms: H. de Meric (Baillière).—Notes on Cage Birds: edited by Dr. W. T. Greene, 2nd series (Gill).—Wonders of the Bird World: Dr. R. B. Sharpe (Gardner).—The Valley of Light: W. B. Worsfold (Macmillan).—In the Australian Bush, &c.: R. Semon, translated (Macmillan).—An Illustrated School Geography: A. J. Herbertson (Arnold).—Calendario del Santuario di Pompei, 1899 (Valle di Pompei).—Continuous-Current Dynamos: J. Fisher-Hinnen (Biggs).—Traité Élémentaire de Météorologie: Prof. A. Angot (Paris, Gauthier-Villars).

PAMPHLETS.—The Triassic Formation of Connecticut: W. M. Davis (Washington).—A Table of the North American Tertiary Horizons: W. H. Dall (Washington).—The Dolmens of Japan and their Builders: W. Gowland (Clowes).

SERIALS.—School World, January (Macmillan).—A Manual of the Geology of India, 2nd edition, Part 1 (Calcutta).—Astrophysical Journal, December (Chicago).—National Geographic Magazine, December (Washington).—Physical Review, December (Macmillan).—Zoologist, January (West).—Agricultural Gazette of New South Wales, November (Sydney).—Journal of the Sanitary Institute, January (Stanford).—Quarterly Review, January (Murray).—Journal of the Chemical Society, January (Gurney).—Archives of the Roentgen Ray, November (Rebman).—Journal of the Franklin Institute, January (Philadelphia).—American Naturalist, January (Ginn).—Popular Astronomy, January (Wesley).—The Technology Review, January (Boston).—Chambers's Journal, February (Chambers).—Good Words, February (Isbister).—Sunday Magazine, February (Isbister).—American Journal of Mathematics, January (Baltimore).—Century Magazine, February (Macmillan).

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THURSDAY, FEBRUARY 9, 1899.

A HISTORY OF COAL MINING.

Annals of Coal Mining and the Coal Trade. By R. L. Galloway. Pp. xii + 533. (London: The *Colliery Guardian* Co., Ltd., 1898.)

THE scientific study of any art or industry demands, almost as a matter of necessity, that its history should not be neglected, for it is only when its mode of evolution has been clearly traced that the principles upon which it depends can be thoroughly understood. The proper scientific training of the coal miner is a subject that is at present engaging the attention of a large number of those interested in this branch of industry, and to all these Mr. R. L. Galloway's history of coal mining—for such his work really is—will come as a welcome educational weapon; nor will it prove any the less valuable because it has obviously been written without any specific intention of applying it to this purpose.

The author's object has simply been to write a history of the coal trade in Great Britain, and to trace the gradual rise and progress of coal mining from its small and almost accidental beginnings to the present gigantic industry employing directly something like three-quarters of a million of workers, and producing over two hundred millions of tons of coal annually, so that, although no record of its existence can be traced before the twelfth century, the coal trade at the end of the nineteenth may fairly be looked upon as the chief source of England's wealth and the mainstay of her greatness. Obviously enough, such a history cannot fail to be of fascinating interest from almost every point of view, and although Mr. Galloway is by no means the first who has attempted to sketch it, his work compares favourably with those of his predecessors; moreover, it is evident that it has been to him a labour of love, and that he has spared neither time nor trouble in collecting information bearing upon his subject, from all available sources.

In the earlier portion of the record, very much is guess-work, and we get little that is definite or clear before the beginning of the fourteenth century. Incidentally it may be noted that Mr. Galloway's derivation of the word "mine" from "an Eastern root signifying weight," can hardly be endorsed. Its real derivation seems to be from the Low Latin word "minare," meaning to lead or drive, derivatives of which are found in such words as "prominent" and the French "mener"; it would thus seem that etymologically the word "mine" was identical in meaning with the more modern "lode" or "lead," and was originally applied to a deposit of mineral as distinguished from the mineral itself. Numerous entries concerning the digging, and occasionally even the selling of coal, before the end of the fourteenth century, seem to have been disinterred, and it is curious to note that most of them are from ecclesiastical records; indeed the Bishops of Durham seem to have been, if not the very first, certainly among the first of the great coal-owners of the country, a circumstance that may perhaps be due to the ease with which coal was got originally at the outcrops of the numerous fine seams of the great Northern coal field. Mr. Galloway remarks on the meagreness of the records in other parts of England compared with what there is known respecting this one.

It is worth mentioning that there exists at Durham a lease a little earlier than any quoted by Mr. Galloway, bearing the date, namely, of 1325; this curious document shows that coal mining must already have reached a certain stage of development, as it draws a distinction between "pykemen" and "schafteman." During the next two centuries comparatively little is heard of the technical aspect of coal mining, but a great deal of its commercial development, which was not a little influenced by the rapidly increasing employment of this fuel for domestic purposes. As pointed out by the author, the close of the sixteenth century marks a definite epoch in coal mining, in that it corresponds approximately with the exhaustion of the greater part of the coal lying above the natural water-level, so that the mineral had now to be wrought at depths below the level of the water, and the necessity for combating this formidable enemy was now beginning to make itself severely felt. What was destined to be the most important event of the seventeenth century was, however, the commencement then made to construct railways with flanged wheels for the more ready carriage of coal from the pits to the shipping places, an idea which, seemingly of the smallest importance, was the true germ whence sprang later on the invention of railways, an invention destined to revolutionise not the coal trade alone, but the aspect of the whole civilised world. It was not, however, till the next century that the steam engine was invented; originally used for the purpose of unwatering collieries, its increasing application to all branches of industry caused the demand for coal to advance by leaps and bounds. Mr. Galloway has rightly, therefore, interwoven the history of the steam engine with that of coal mining; it would, indeed, have been difficult to have separated them, and the history of one is to a great extent the history of the other. An event of the utmost importance in the development of the coal trade was the success attained by Abraham Darby, about 1730, in smelting pig-iron with coke; Mr. Galloway certainly mentions the fact, but does not lay the stress upon it which its importance would appear to merit, nor does he even record the name of the man to whose energy and perseverance ultimate success was due after a century of failures. Nor, again, is anything like sufficient weight given here to Neilson's invention of the hot blast, a century later.

These two monumental improvements in the art of iron-making, firstly by stimulating enormously the demand for coal, and secondly by supplying the mining engineer cheaply with the constructive materal which he needed for his machinery, contributed in a degree second only to the invention of the steam engine, to the rapid expansion of the coal mining industry. As said above, the history of coal mining is to a great extent that of the steam engine; but neither chronicle is complete until it is supplemented by that of the manufacture of iron, and perhaps the only serious fault

that can be found with Mr. Galloway's book is that he has attempted to write the annals of the coal trade as apart from its twin industry of iron-making. The complexity, however, of the history of coal mining by itself may fairly be held to excuse, to some extent, this shortcoming.

The close of the eighteenth and the early years of the nineteenth century were prolific in great advances in the technique of coal mining, the invention of the safety lamp being, perhaps, one of those of most importance, although its value had not yet been fully recognised in 1835, the date at which the author closes these interesting annals. They stop short, therefore, at the dawn of the true age of steam, at the era of the railway and the steamship; it is on this ground to be regretted that the author has not extended his review yet another thirty years or so further, when he would have fittingly rounded off his picture. He has done his work so well, has brought so much industry and research, coupled evidently with a thorough knowledge of the subject, to bear upon his task, that he has succeeded in reproducing a most complete picture of the evolution of the coal-mining industry. It can only be hoped that at some future date he may continue these interesting records down to the present day. H. LOUIS.

AN ATLAS OF BACTERIOLOGY.

An Atlas of Bacteriology. Containing 111 Original Photomicrographs with Explanatory Text. By Chas. Slater, M.A., M.B., M.R.C.S. Eng., F.C.S., and Edmund J. Spitta, L.R.C.P. Lond., M.R.C.S. Eng., F.R.A.S. Pp. xiv + 120. (London: The Scientific Press, Limited, 1898.)

IT might be said that the illustrative side of the science of bacteriology, whether by photographs, drawings, or coloured pictures, is, to some extent, overdone, and that the "Hand-Atlanten" of Lehmann and Neumann and the Atlas der Bakterienkunde by Fränkel and Pfeiffer already cover the whole field. Further, that the modern textbooks of bacteriology are filled with numerous and useful illustrations, and have, of course, in addition the advantage of containing a complete and elaborate description of the morphological and biological characters of all the most important bacteria, besides all other information necessary to a correct knowledge of the science of bacteriology.

Yet, on careful study of this work, it is impossible to deny that it fills a blank in the life of the student of bacteriology. In the first place, most of the photographs are excellent, and the letterpress, linking together and explaining the teaching of the illustrations, is clear, concise and accurate. In the second place, the book is compactly bound, is printed on excellent paper in good type, and is of a very handy size. Thirdly, the authors can claim to have succeeded in giving in a limited number of illustrations a very complete series, so far as the wants and requirements of the average student of bacteriology are concerned. Lastly, its price is well within the limits of even a very slender purse.

For the purpose of this notice the book may be divided as follows:—

(1) Photographic introduction (pp. 1 to 9). This introduction, although doubtless of value from the viewpoint of the micro-photographic expert, might reasonably be clothed in simpler language for the sake of the average reader.

(2) Bacteriological introduction (pp. 10 to 23). Although this is well written, the purpose it serves in a condensed atlas of bacteriology is not very clear. It detracts a little from the scope of the work, which presumably is to present to the student a condensed photographic record of the chief morphological and biological characters of those bacteria which he is most likely to have to investigate in the course of his bacteriological studies.

(3) Photographic records of the more important bacteria, with explanatory notes (pp. 24 to 108). Photographs are given of two micro-organisms recently discovered, and these of great importance, namely, *Bacillus pestis bubonicae* and *Micrococcus melitensis*. These same microbes are generally believed to be non-motile, and competent observers have failed to demonstrate the presence of flagella. Dr. M. H. Gordon, however, has succeeded in obtaining specimens in which the flagella, both of the bacillus of plague and the micrococcus of Malta fever, are clearly visible.

All the photographs are good and some are excellent. To the latter class belong, among others, the following: Fig. 11.—*B. typhi murium;* Fig. 93.—Sp. *Obermeieri;* Fig. 111.—*Plasmodium malariae* (malignant Tertian); Fig. 78.—Sp. *cholera Asiatica;* Fig. 56.—*B. typhosus;* Fig. 49.—*Micrococcus gonorrhoea;* Figs. 25, 26, 27, 28.—*B. tuberculosis;* and Fig. 12.—*B. mycoides.* Much less satisfactory photographs are Figs. 50, 51, and 52.—*B. typhosus.*

A very large number of the illustrations depict coverglass specimens. It is a pity that more photographs are not given of cultures of the bacteria. No doubt these are frequently unsatisfactory, but the general excellence of Messrs. Slater's and Spitta's present work suggests the belief that their efforts in this direction would be crowned with success. For example, gelatine plate cultures of *B. mycoides* and *B. coli communis*, and agar cultures of *Streptococcus pyogenes* and *Diplococcus pneumoniae* under a low power of the microscope.

Of photographs of bacteria that might with advantage be added the following may be mentioned:—Anaerobic milk cultures of *B. enteritidis sporogenes* (Klein); impression preparation of the "swarming islands" of *Proteus vulgaris;* microscopic preparation of *B. coli communis* stained for flagella. This last is extremely important, as all students of bacteriology ought to be taught to regard the difference in the number of flagella of *B. coli* and *B. typhosus* as a valuable aid in the differential diagnosis of the two organisms. *B. typhosus* is multi-flagellated. Some varieties of *B. coli* are likewise multi-flagellated, but the true *B. coli communis* has only 1-3 flagella.

These criticisms are offered in no carping spirit, for we are struck with the general excellence of this Atlas of Bacteriology, and we can cordially recommend it not only to students but to all those who make this science their special study. A. C. HOUSTON.

OUR BOOK SHELF.

The World's Exchanges in 1898: a Reckoner of Foreign and Colonial Exchanges. By John Henry Norman. Pp. 54. (London: Sampson Low, Marston, and Co.)

ONE of the main objects of this pamphlet is to show how, by the use of the Chain Rule, the principles and practice of foreign exchanges can be brought down to the understanding of pupils of secondary and continuation schools. The author's purpose is "to prove by very simple arithmetical formula (*sic*) (1) that if the world possessed but one substance as its measure of value and equivalent in exchange, the world's interchanges of things could be effected on the conditions of barter. (2) That there are in the trading world at the present time seven different monetary and currency intermediaries, five of which are of a vastly different nature. (3) That these seven different intermediaries produce forty-two different prices of intermediaries, some of which either confer a bounty or impose a tax in international or intercolonial exchanges of things, resulting in the unfair encouragement of production of things in some countries and the handicapping of industries in other districts to an extent which can be measured by heavy percentages."

Heads of English business firms have lately received some pretty strong hints in the public press that they are losing trade all over the world because their foreign representatives will not give quotations in the currencies and weights and measures which are understood in the country they are trading with. A perusal of the present pamphlet should suffice with a little practice to enable any clerk to make the necessary calculations. But if the multiplications and divisions required in using the Chain Rule are not to be made the subject of pages of long strings of meaningless figures, often ending in answers ten times too great or ten times too small, far more attention must be given to approximate methods of working with decimals than is afforded at most of our schools. In this respect our foreign competitors score, as the metric system provides for them an easy introduction to decimals, which latter they can master in far less time than is taken by our schoolboys in floundering through the British labyrinth of perches, kilderkins, nails, fathoms, and pennyweights. G. H. B.

Lecture Notes on the Theory of Electrical Measurements. By Prof. W. A. Anthony. Pp. 90. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1898.)

IN the few pages of open print which go to make up this little work, Prof. Anthony gives a sketch of his course of lectures on elementary measurements in electricity and magnetism, in which, while enlarging upon the theoretical part, he merely indicates the experimental and practical part by a number of disjointed notes.

This irregular treatment of subject-matter is quite intentional, the aim of the book being simply that of enabling the careful student to illuminate those passages of his lecture notes which are likely to be obscure. But the irregularity naturally makes the book unsatisfactory both for perusal and for reference. For while such a work may be beneficial to a certain type of student, and would doubtless be of value to students of Prof. Anthony's classes; yet it may be questioned whether works of this kind can with advantage be recommended to beginners, or whether these would take kindly to a book in which all superficially interesting matter is avoided, and the uninteresting alone retained.

The book is by no means free from misprints and other slips: as "ratios" for "ratio" on p. 36; x for X in the equation on p. 53; again, the statement on p. 61 that "the potential difference between the ends of a potentiometer slide-wire may be varied by shunting a part of its current away," seems to us misleading if not inaccurate. The diagrams also, though few in number, are somewhat open to criticism; thus we think the forces in Fig. 3 should be so drawn as to represent a state of equilibrium, while the figure on the succeeding page is almost unintelligible owing to the deflecting force not being drawn at right angles to the needle.

Apart, however, from such blemishes, and putting aside questions of general utility, it must be conceded that the matter in this little book is well arranged, and the new conceptions admirably introduced; while the deductions of well-known formulæ are in many cases very neatly given. D. K. M.

The Micro-organism of Faulty Rum. By V. H. Veley, M.A., F.R.S., and Lilian J. Veley (*née* Gould). Pp. 64. (London: Henry Frowde, 1898.)

BACTERIAL idiosyncrasies are now so familiar and so numerous, that it is difficult for us to be taken unawares any more by the whims and peculiarities of these groups of lowly organisms. Mr. and Mrs. Veley have, however, succeeded in discovering an oddity which, even in this remarkable community, stands out in relief. Whilst studying the causes of faulty rum, these investigators have come upon an organism which, in its lust for sugar, will brave the untoward surroundings of a liquid containing over 70 per cent. of alcohol. This is an unheard-of feat amongst these low forms of life. To enable it to indulge in sugar in such environment, this organism surrounds itself with a gelatinous envelope which, whilst permitting it to obtain its favourite food-stuff, protects it from the deleterious effect of the alcohol, and these characteristics have been embodied in the name *Coleothrix methystes* selected for it by its discoverers—Κολεός, a sheath, μεθυστής, a drunkard. Unfortunately for spirit distillers, this organism elects to dwell in rum, producing, according to Mr. and Mrs. Veley, a change in the spirit which, under the title of "faulty rum," occasions losses of some thousands of pounds annually to manufacturers. The life-history of this said *Coleothrix methystes* is by no means an easy one to trace; in fact, the various phases through which it is said to pass embracing such transformations as coccus to rod, coccus to filament, and filament to coccus forms, leave its identity still open to speculation and further inquiry; indeed, as the authors themselves modestly remark, "a subject of legitimate controversy." Whatever may be the results of such legitimate controversy, only praise is due to the authors for the conscientious care and the great labour they have bestowed upon this most difficult piece of work; and, doubtless, now investigators have been started in this direction, many will be stimulated to travel over the same ground, and further extend our knowledge on such an interesting and novel subject as the possibilities of life in liquids containing such a high percentage of alcohol.

G. C. FRANKLAND.

Les Recettes du Distillateur. By Ed. Fierz. Pp. 149. (Paris: Gauthier-Villars, 1899.)

THIS book contains an exposition of an art peculiarly French—the preparation of liqueurs, recipes being given for upwards of 150 essences. Stress is laid upon the necessity for using absolutely pure materials, the quality of the alcohol employed being of especial importance, and tests are given for empyreumatic oils, the presence of which would be particularly injurious. The alcohol is aromatised by distillation or digestion with suitable plants or roots, the alcohols used in the preparation of some of the liqueurs requiring the addition of upwards of twenty ingredients in this preliminary operation, and this is then mixed with sugar syrup, pure alcohol, colouring materials and essences to form the liqueur. The instructions are both detailed and precise.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Alleged Destruction of Swallows and Martins in Italy.

I AM naturally adverse to polemics, for I believe that what little time we have can be better employed. And yet, as an old client and reader of NATURE, and as Director of the Italian Bureau of Ornithology, I can hardly allow the several communications on the alleged decrease of swallows and martins and the destruction of small birds in general in Italy, which have appeared in recent numbers of NATURE (see p. 271), to pass without a comment.

That small birds are netted and eaten in this country is a fact which many of us deplore, and we are trying to prevent, or at least to diminish, that kind of destruction with regard to small birds, all of which I consider useful. But as to the Hirundinidæ, no such ruthless destruction as that described by Mr. J. H. Allchin takes place in Italy. To my knowledge no swallow or martin is ever netted in this country, and I confess that I should like to see such birds captured with a fish-hook! I can only ask Mr. Allchin if he candidly believes it possible to catch swallows in great numbers with artificial flies and fish-hooks? I simply do not. In Italy the Hirundinidæ are, besides, the only birds which owe protection to popular belief: in many localities they are considered "the birds of the Madonna," and it is considered unlucky to destroy them. I can assure Mr. Allchin that no decrease of the Hirundinidæ (nor indeed to a certainty of any other small Passerine bird) has been detected in Italy.

Finally, if Mr. Allchin is really desirous of acquiring trustworthy information on the condition of birds in Italy, instead of consulting the newspaper articles of Mr. Stillman, the veracity of whose assertions on such matters may be doubted, or still worse of quoting "Ouida" as an authority on a subject of which she knows nothing, he would do well to betake himself to the library of the British Museum, or to that of the London Zoological Society, and consult the four volumes which by Government commission I have published on the Avifauna of Italy[1]; the three last being the results up to 1891 of an official inquiry on the condition of each species of bird, carefully conducted by trained and experienced observers all over the country. This inquiry is yet going on, and possibly a second report will soon be issued. Mr. Allchin is also evidently misinformed as to the international aspect of the question; at least, so far as Italy is concerned.

HENRY H. GIGLIOLI.

R. Zoological Museum, the University,
Florence, January 27.

The Hatching of Tuatara Eggs.

IN a memoir on the development of the Tuatara, which I am shortly about to publish, and upon my preliminary notes on which an interesting comment by Mr. G. A. Boulenger, F.R.S., has recently appeared in the pages of this journal (NATURE, vol. lviii. p. 619), I have come to the conclusion that the eggs of this reptile hatch about December of the year following that in which they are laid, and that they thus occupy about thirteen months in their development. Hitherto, so far as I am aware, no specimens have actually been hatched out in captivity, or under direct observation. On December 1, 1898, however, Mr. P. Henaghan, the keeper of the lighthouse on Stephen's Island, brought to my laboratory some eggs which had been recently laid, together with others laid during the previous season. On unpacking the eggs, one of the latter was found to be already hatched, having yielded a fine, active young Tuatara, which is still (December 21) in a state of vigorous health, though it has not been observed to eat anything. On December 8–9 a second specimen hatched out, though I am inclined to think a little prematurely, as a large part of the yolk-sac was still attached. These specimens agree closely with the dead specimens of Stage S. received by me last year, and described in my memoir, but it seems worth while to place on record the actual time of hatching, although the new observations only confirm the conclusions already arrived at. The hatching probably continues throughout the month of December, as the eggs of last season, opened during the last few days, each contain a considerable amount of yolk, together with the very advanced embryo.

A point which seems worthy of attention is the large size of the eggs containing embryos nearly ready to hatch. Two eggs opened on December 17, and containing embryos at Stage S., measured 35 × 27·5 and 32·5 × 26·5 mm. respectively, while recently-laid eggs opened on December 21, and containing embryos of about Stage N., were much smaller, the six measured ranging from 25·5 × 20 to 29 × 22 mm. These observations certainly seem to confirm the opinion of Mr. Henaghan that the eggs swell during development, which I have been at some pains to controvert in my memoir. It must be remembered, however, that the eggs of the Tuatara vary considerably in size.

The eggs nearly ready to hatch are still very tense and turgid. In hatching, the leathery egg-shell appears to be simply torn or split irregularly, probably by the shell-breaker of the young animal. In the recently-hatched animal the nostrils are still plugged up, though the plug appears to be loosening, and after a short while it completely disappears externally.

ARTHUR DENDY.

Christchurch, N.Z., December 21, 1898.

THE afore-mentioned memoir, by my friend Prof. Dendy, has been accepted by Prof. Lankester, F.R.S., for the *Quarterly Journal of Microscopical Science*, and is about to appear in the February number of that journal, to be followed immediately by another on the Pineal Eye; Prof. Lankester having arranged for publication with that generous enthusiasm he extends to all good work. As already announced in these pages, Prof. Dendy sent me last autumn some preserved material for the investigation of the development of the Tuatara's skeleton, and with it half-a-dozen eggs due for hatching about December. The latter were in moist sand packed tight in a tin canister, and were brought by Mrs. Dendy in her cabin, on a voyage to England. Upon delivery they were transferred to a hot-air bath and kept at an approximate temperature of 25° C. One embryo decomposed, and a shell, containing another, having collapsed, was opened by my pupil, Mr. H. H. Swinnerton, who is co-operating with me in the task of investigation. The other four were opened by the enclosed embryos; one prematurely on November 22, the others respectively, and at the full time, on January 14, 19, and 24 of the present year. The embryo which emerged prematurely had a pendant yolk, and was but a centim. shorter than those of Dendy's Stage S. in my possession. The three young ones which remain left the egg with the yolk absorbed, and they continue active and healthy. Although their incubation period would appear to have exceeded that of those hatched out in Prof. Dendy's laboratory, the largest egg-shell measured but 31·5 × 24 mm., the smallest 28·5 × 21 mm. The apparent swelling of the shell, alluded to by Prof. Dendy, had independently arrested the attention not only of both Mr. Swinnerton and myself, but also of our laboratory attendant, George Woodrow, who in December remarked to me that "the eggs seemed rising above the sand"; and the phenomenon would appear to be due to internal tension, no doubt resulting from the actual growth of the enclosed embryo. One of the young ones had just liberated itself as we arrived on the morning of January 24, and we were able to note that on leaving the shell it lay torpid beside it for a period less than an hour, and then with a sudden start ran briskly forward. One of the youngsters, tempted on the day of hatching with a small earth-worm, ran from it affrighted, and by all three meal-worms are still refused. "Bluebottles," however, are eagerly devoured, and upon these all are at present thriving, with every indication of success. Concerning the rupture of the egg-shell, the four shells from which the young in my possession escaped were each cut cleanly, as by a razor, along the long axis. In the case of the prematurely hatched embryo, the incision extended the whole of one side, from pole to pole, while in that of each which went the full time it started short of one pole and extended longitudinally round the other to an approximately corresponding point on the opposite side. In every case the underlying serous envelope was similarly clean cleft, and on examination of the newly-

[1] E. H. Giglioli, "Avifauna Italica," pp. vii–626. Firenze, 1886. "Primo Resoconto dei risultati della inchiesta ornitologica in Italia." Parte I., "Avifauna Italica," pp. vii–706. Firenze, 1889. Parte II., "Avifaune locali," pp. viii–695. Firenze, 1890. Parte III., "Notizie d'indole generale," pp. vii–518. Firenze, 1891.

hatched embryo with its mouth closed, the egg-breaker was seen to form a sharp downwardly directed prominence, projecting freely, and in such a position as to leave little room for doubt that it is the direct agent in rupturing both membrane and shell. It may be added that in the three living specimens in my possession all traces of the egg-breaker have vanished—*i.e.* in that last hatched within seven days. G. B. HOWES.

Royal College of Science, London, January 31.

Attraction in a Spherical Hollow.

THE theorem of attraction stated by Prof. T. Alexander in NATURE of January 19, is a particular case of a more general theorem which I have not seen stated, though very likely it is not new. The well-known theorem of *couches de glissement* is also a case of it. Imagine two spheres, one of radius r and made of positive or attracting matter of density σ, the other of radius r' and made of negative or repelling matter of the same density σ, to coexist even if they overlap. In the space common to the two spheres the one kind of matter neutralises the other, so that the space may be considered as empty. The force on a unit particle of positive matter, placed at any point on the circle of intersection of the two surfaces, is parallel to the line of the centres A, B, of the two spheres and of amount $\frac{4}{3}\pi\sigma\kappa c$ where σ is the common density of the spheres, c the distance between their centres, and κ is the usual attraction constant. For the positive sphere attracts the particle towards the centre with a force $\frac{4}{3}\pi\sigma\kappa r$, and the other sphere repels the particle from its centre with a force $\frac{4}{3}\pi\sigma\kappa r'$. These forces give the resultant $\frac{4}{3}\pi\sigma\kappa c$ parallel to the line joining the centres of the spheres and from the repelling centre towards the other.

This resultant force is independent of the radii of the spheres, provided their centres remain at the same distance apart. It follows that the force at all points within the space common to the two spheres is parallel to the line joining the centres, and has the value just stated. For take any such point P and describe through it spherical surfaces about the centres A, B. The portions of the two spherical distributions which lie outside these surfaces exert no force at P. The spheres internal to P give the force $\frac{4}{3}\pi\sigma\kappa c$.

If one of the spheres is wholly within the other, we have the theorem of the force within a spherical hollow. It is only necessary in that case to suppose the hollow formed by the superposition of negative matter on the previously existing positive matter, and the result follows at once.

I may point out that a theorem similar to and including that stated above holds for two overlapping similar ellipsoids, of equal and opposite densities, and having their corresponding principal axes in the same directions, and one pair of these, say the axis of x of each, in the same line. The centres A, B lie on this line, and any point common to the two ellipsoids will have coordinates x, y, z, say, when referred to axes through A, and x', y, z when referred to parallel axes through B.

Taking, then, as axes of coordinates the principal axes of each ellipsoid, and considering any point in the overlapping portion, and describing through P about A, B as centres two ellipsoidal surfaces S, S′, each similar to the given ellipsoids, we obtain for the components of force on a unit particle due to the positive (say) matter of uniform density σ filling S, the values A_1x, A_2y, A_3z; and for the components of force at the same point due to the negative matter filling S′ the values

$$-A_1x', \ -A_2y, \ -A_3z$$

where A_1, A_2, A_3 are certain integrals which are here constants. The portions of the two ellipsoids external to P exert no force at P. Hence the resultant force on the particle at P is $A_1(x-x')$, that is, it is parallel to the line joining the centres, and proportional to the distance between the centres, and acts from the centre of the repelling towards that of the attracting ellipsoid.

If the coordinates of B, relatively to the axes through A, be a, b, c, so that there is not a pair of corresponding axes in line, the components of force in the overlapping space are A_1a, A_2b, A_3c. The force at every point is $\sqrt{A_1^2a^2 + A_2^2b^2 + A_3^2c^2}$, and is therefore fixed in magnitude and direction.

With reference to the magnetic experiments, it may be recalled that if within a uniformly magnetised ellipsoid there exist a similar ellipsoidal hollow, with its axes parallel to those of the magnetised ellipsoid, the magnetic force within the hollow is zero at every point. A similar result holds, of course, for a sphere. ANDREW GRAY.

Larvæ in Antelope Horns.

I HAVE read with interest the communications of your correspondents on "Larvæ in Antelope Horns" in NATURE of September 15, and also another note on the same subject in *The Entomologist* of July last; but NATURE of June 9, for some reason or other, has not reached me.

As for many years past I have been travelling and residing in Central Africa, have shot large and small game, and have made large collections of the heads of buffalos and antelopes, I have thought that it may be worth while to record my own observations in this matter.

Is it the fact, proved beyond all doubt, that the larvæ in question are those of Lepidoptera and not of Coleoptera?

My own experience is that, unless preventive measures (such as I am about to describe) have been taken in the first instance, the horns of my specimens become infested with the larvæ of what I have hitherto believed to be two small species of *Coleoptera*—the one and smaller of bright metallic-green throughout, the other and larger of dull coal-black above, and white on the underside—which larvæ eat their way up and through the horns, throw out cocoons, and continue doing so until the horns are destroyed, leaving nothing but the cores.

If the heads have been neglected, and left in the open—say either on the ground, or in a tree—the larvæ very soon develop and commence their depredations, all the sooner if the heads have been left with the skin and flesh on.

If, however, these last be removed within a few hours after the animal has been killed, and the bases of the horns and their cores be carefully lathered over with strong arsenical soap where the skin has been cut away from round the horns, and between these and their cores as far up as the hairs of the brush will reach, the larvæ do *not* develop; and heads thus treated, if properly housed, henceforth enjoy absolute immunity from them.

I have a collection of antelopes' heads treated in this way now at Machako's, and though of all ages up to ten months old, there is not a perforation or a cocoon in any one of them; whereas, on the same station, I have noticed that the horns collected by other officers, and not properly cared for, become, most of them, after a time, simply perforated and woolly with cocoons.

Should the larvæ have established themselves, they can readily be killed by pouring paraffin into the horns, and leaving these on end for a day or two so as to retain the oil.

Never once have I remarked these larvæ in the horns of a freshly-killed animal.

I have, however, occasionally found the larvæ of *Diptera* in the flesh of some antelopes—notably so lately in Masailand in the case of a fine male Grant's gazelle, whose body, otherwise in first-rate condition, after being skinned, presented the spectacle of being "flicked" white with larvæ about the size and shape of barleycorns, at intervals of two inches or so.

A propos of the destructive little Coleoptera once more:—

On landing in England from Africa in the spring of 1884, I was at Euston, and amongst my battered and travel-stained baggage on the platform was a large truck-load of buffalos' and antelopes' heads. As I was standing talking to one of my brothers who had come to meet me, an old gentleman, who had been narrowly inspecting the load of heads, suddenly stooped down, and concentrated his gaze on one particular spot: then, fumbling in the pocket of his tail-coat, he produced a pill-box, and dexterously boxed something from one of the buffalo heads. It proved to be one of the green beetles!

Then turning, and realising that I must probably be the owner of the heads, he politely raised his hat and apologised for what he had done, adding that he had taken a species of Coleoptera which—I think he said—was new to him.

I lost no time in assuring him that no apology was necessary, that the obligation lay on my side, not on his!

Mr. Lionel Crawshay, my brother (whose address is Brasenose College, Oxford), can, I think, show you specimens of the green beetle, and possibly of the other as well: if not, I shall be very pleased to send you a series of both; as also, if you wish them, specimens of horns perforated by the larvæ and with their cocoons attached. RICHARD CRAWSHAY.

Simba Camp, British East Africa, November 29, 1898.

P.S.—As an afterthought, I am enclosing you 2 specimens of the green beetle 2 specimens of the black beetle, and 2 larvæ, which I hope will survive the post. R. C.

MR. CRAWSHAY'S interesting letter does not affect the question of *Tinea vastella* and its feeding on horns. Reference to the authorities quoted in your issue of September 15 last, or to the accounts of Lord Walsingham (*Trans. Ent. Soc. Lond.*, 1881, p. 238; *id. Proc.*, 1881, p. viii., 1882, p. xx.), and Mr. R. Trimen (*Trans. S. Afr. Phil. Soc.*, iii. p. 24), shows that the moth has been bred repeatedly from horns, and in one case, from a hoof of the troop-horse killed with the Prince Imperial in Zululand, and by naturalists whose competence is beyond question. Recently M. de Joannis has described (*Bull. Soc. Ent. France*, 1897, p. 109), the emergence from buffalo and ox-horns in Algeria of a large number of examples of a new Tineid moth, *Tineola infuscatella*, together with a few specimens of *Blabophanes nigricantella*, Mill., *B. imella*, Hühn., and *Trichophaga bipartitella*, Rag., the larvæ of which moths had apparently also fed upon the horn-substance.

The horn-feeding habit cannot be impeached; but I do not regard the evidence hitherto brought forward as to the horns of a living ruminant being attacked, as absolutely conclusive. With respect to infestation of horns of newly-killed animals exposed for sale in African market-places, it has, I believe, been stated (although I am unable to give any reference thereto) that the natives are in the habit of "faking" old horns for sale by anointing their bases with fresh blood.

Mr. Crawshay's communication is of importance, however, as calling attention to the existence of other horn-attacking insects. The beetles which he has forwarded are examples of *Necrobia rufipes* (or an allied species—his "green beetle") and a *Dermestes*, which cannot be identified from the poor material sent. The larvæ are those of the *Dermestes*.

It is not news to myself, nor, I imagine, to other entomologists, that these beetles are often as common in uncleaned horns or skulls of African animals, as they are in many bone-houses in this country. When the skeleton of the African elephant, now in the Museum of Zoology and Comparative Anatomy at Cambridge, was unpacked, these two (or similar) species fell out of the bones literally in pints. I question, however, whether either of them attacks horns from which the cores and all matter other than the horn-substance have been removed. That the latter was extensively burrowed in Mr. Crawshay's examples is not by itself a proof, for that remarkable and destructive insect, *Dermestes vulpinus*, has the habit, as an adult larva, of attacking any substance that will yield to its jaws, not for food, but for the purpose of forming a suitable nidus in which to pupate. It is thus sometimes exceedingly injurious to woodwork, as in a case, by no means isolated, observed by myself in 1890, where it occurred in great abundance in the bone-sheds of a soap-works, and destroyed all the timbers so rapidly that three new roofs were required in the space of a year, even the scaffold-poles used in their erection being damaged. The fir rafters were hollowed out along the layers of the spring-wood into very thin and brittle concentric laminæ; and the damage had much resemblance to that of the most destructive species of Termites. The species, now cosmopolitan, but perhaps of Oriental origin, had been imported into the works in a cargo of Indian bones, and was never abundant or injurious so long as boiling was resorted to for extraction of grease from the bones. Their multiplication dated from the introduction of a method of fat extraction by a solvent which left behind the fragments of muscle, cartilage, &c., adhering to the bones, as well as the gelatin. It was pointed out to me, and, though incredulous, I satisfied myself of the truth of the observation, that the larvæ occasionally enlarged the "blow-holes" in the friable brickwork of the sheds in order to turn them into pupal chambers. On one occasion a workman left in the sheds a white-spotted blue handkerchief; by the next morning every white spot had been gnawed out of it.

Not only is *Dermestes vulpinus* injurious to hides, leather, furs, bones and, secondarily, to woodwork. In India it is destructive to stored silk-cocoons. I have examined examples of, I believe, this identical species unwrapped from cat-mummies, and have received it from Hong Kong, where it had damaged bunting flags in the Naval Depot. This injury was, no doubt, due to the burrowing of larvæ which had bred in provisions or the like stored near the flags.

A still stranger instance of its habits has been lately communicated to me by Sir H. Trueman Wood, to whom a correspondent, a provision preserver in Australia, sent specimens as examples "of a grub or weevil which derived its sole sustenance from salt." Accompanying them were lumps of salt (agglomerations of fine crystals such as table-salt is apt to form), which were bored through by the insects in such a manner as to lead any non-scientific person to suppose that it had actually been done for the purpose of feeding!

Mr. Crawshay's mention of cocoons on the outside of the horns is not easily reconciled with what is known of the habits of *Necrobia* or *Dermestes*. The species of the former genus, like other Clerids, probably form a cocoon, but are unlikely to do so in an exposed situation. The pupæ of *Dermestes* are found in the above-mentioned chambers enclosed in the split larval skin.

WALTER F. H. BLANDFORD.

London, January 27.

Indian Solpugæ or Pseudo Spiders.

IN your issue of April 28 last there is an interesting article by my friend Mr. R. I. Pocock, of the British Museum, on the Solpugæ (Pseudo Spiders). In that article he does me the honour to refer to certain information I gave him, and to my having allowed numbers of them to bite me to prove to the natives of India that they were not poisonous. Mr. Pocock gives the native name as I gave it to him phonetically as "Jerrymanglum." I have since found that the correct spelling of the word is "Jalamundalum," which is used in the Tamil and Telegoo (Dravidian) languages to denote the larger spiders (Pæcilotheria), the Whip Scorpions, and generally to any animal of the kind which they dread. The derivation is from "Jala," which means heat, fever, or perspiration; and "Mundalum," a period, usually forty-seven days; the belief being that a bite of one of the spiders, Galeodes or Whip Scorpions, will give fever that may last for forty-seven days. A friend, at my request, got this information from a Brahman B.A. of the Madras University, and I think it is interesting enough to deserve a place in your columns.

H. R. P. CARTER.

20 Priory Road, Bedford Park, Chiswick, W., January 30.

Colouring of Plants.

ON reading the very interesting and suggestive article on "Experiments on the Autumn Colouring of Plants," by E. Overton, in NATURE for January 26, it occurred to me that the following observation might be of interest. While I was in Switzerland last summer, I noticed that different plants of *Sempervivum arachnoideum*, L., growing under apparently very similar conditions, differed much in colour, the leaves of some being very red, especially at the tips and on the dorsal surface; and those of others being of a whitish green, almost or quite untinged with red. Wishing to see if any correlation existed between colour and assimilation, I collected two or three specimens of each kind, planted them in boxes, and, after keeping them on a sunny window-sill for some days, so that the environment might be as far as possible exactly alike for all, I tested them for starch by Sachs' iodine method, and found that the leaves coloured by anthocyanin contained far more starch than those without the red colouring matter. From this it will be seen that my results, so far as they go, appear to differ somewhat from the conclusions drawn by Mr. Overton. Perhaps, however, I ought to add that, unfortunately, I did not examine the leaves carefully to see whether or not the red colouring matter was confined to the epidermis, or extended also to the mesophyll, though my impression is that in some cases, at any rate, it did so. My plants were gathered at the end of July or beginning of August.

MAY RATHBONE.

Backwood, Neston, Cheshire, January 30.

THE ORIGINS OF THE LINES OF α *CYGNI*.[1]

WHEN engaged in the classification of stars, according to their photographic spectra, in 1893[2] I came across two sets of lines of unknown origin, one in the hottest stars, the other in stars of intermediate temperature.

After the discovery of a terrestrial source of helium by Prof. Ramsay, I showed in a series of seven notes communicated to the Royal Society,[3] May–September 1895,

[1] Paper read at the Royal Society on February 2, by Sir Norman Lockyer, K.C.B., F.R.S.

[2] *Phil. Trans.*, A, vol. 184, p. 675.

[3] 1st Note, *Roy. Soc. Proc.*, vol. 58, p. 67; 2nd, *ibid.*, vol. 58, p. 113; 3rd, *ibid.*, vol. 5, p. 116; 4th, *ibid.*, vol. 58, p. 192; 5th, *ibid.*, vol. 58, p. 193; 6th, *ibid.*, vol. 59, p. 4; 7th, *ibid.*, vol. 59, p. 342.

that the cleveite gases, which I obtained by the process of distillation, accounted to a very great extent for the first set.

In 1897 in a series of three communications to the Royal Society,[1] I pointed out that some of the other set of unknown lines in the stars of intermediate temperature, taking *a* Cygni as an example, were due to the enhanced spark lines of iron and other metals, the arc lines being almost entirely absent.

During the last year, this research has been continued; and latterly, by the kindness of Mr. Hugh Spottiswoode, the photographs of the enhanced lines have been obtained by the use of the large induction coil, formerly belonging to Dr. Spottiswoode, P.R.S. I am anxious to express here my deep obligation to Mr. Hugh Spottiswoode for the loan of such a magnificent addition to our instrumental aids.

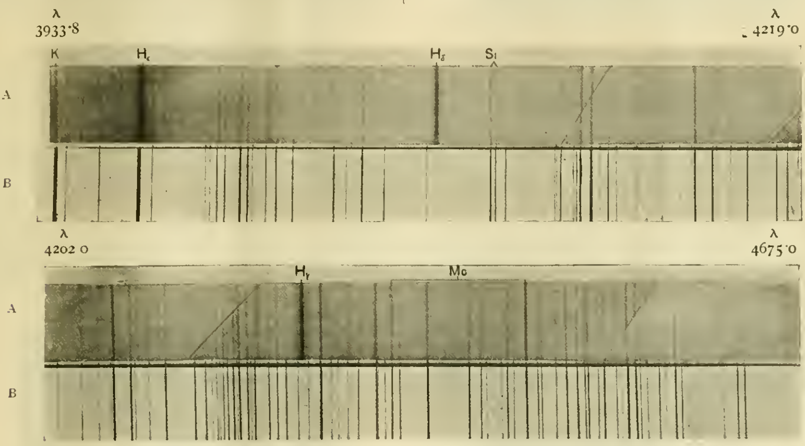
The spark obtained by means of the Spottiswoode coil is so luminous that higher dispersions than those formerly employed can be effectively used, and in consequence of this, the detection of the enhanced lines becomes more easy; their number therefore has been considerably increased.

I shall deal in a subsequent communication, when the inquiry has reached a further stage, with the details for each element.

The lines of the stars of intermediate temperature, like *a* Cygni, have long been recognised by the Harvard observers as well as by myself as presenting great difficulties.

In 1893 I wrote as follows[1]: "With the exception of the K line, the lines of hydrogen and the high temperature line of magnesium at λ4481, all the lines may be said to be at present of unknown origin. Some of the lines fall near lines of iron, but the absence of the strongest lines indicates that the close coincidences are probably accidental." In the Harvard "Spectra of Bright Stars," 1897, p. 5, the following words occur, relating to the same stars: "This system of lines should perhaps be regarded as forming a separate class, as in the case of the Orion lines, and should not be described as 'metallic,' as has just been done in the absence of any more distinctive name."

From the fact that these unknown lines have now been traced to a "proto-metallic" origin, as effectively as the unknown lines of the hottest stars have been traced to



Comparison of *a* Cygni and the enhanced lines of certain metals (chiefly of the iron group).
A = spectrum of *a* Cygni between wave-lengths stated. B = spectrum of enhanced lines.

helium and asterium, we may expect that the consequences of this determination in relation to stellar classification and other connected matters, will be very far-reaching. At present I am using this new spectrum consisting of enhanced lines as an explorer, in relation to some further details of stellar classification having special reference to stars of Groups III. and IV. in which bright as well as dark lines occur.

The observations have already been mapped for the following substances:—

Iron, manganese, nickel, cobalt, magnesium, chromium, calcium, strontium, copper, vanadium, titanium, silicon.

In the accompanying photograph, a comparison is shown between the lines of *a* Cygni and the enhanced lines of the above substances thrown together. The extraordinary number of coincidences is seen at a glance. The facts are as follows:—

The number of lines measured in the spectrum of *a* Cygni at Kensington between λ3798·1 and λ4861·6 is ...	307
Of these the number which approximately coincides with the enhanced metallic lines so far observed is	120
The number of lines (excluding the hydrogen series) in *a* Cygni of intensity over 4 (the maximum being represented by 10) is ...	40
Of this number, the coincidences with enhanced metallic lines with the dispersion employed amount to ...	38

[1] *Roy. Soc. Proc.*, vol. 60, p. 475; *ibid.*, vol 61, p. 148; *ibid.*, vol. 61, p. 441.

[1] *Phil. Trans.*, A, vol. 184, p. 694.

HIGH ELECTROMOTIVE FORCE.[2]

IN the course of my investigation of electrical oscillations I have been enabled, by a simple transformation of my apparatus, to study electrical discharges of greater intensity and length than have hitherto been obtained in atmospheric air. These discharges are produced by means of a storage battery of ten thousand

[2] Extract from a lecture delivered by Prof. John Trowbridge before the American Academy of Arts and Sciences, at a meeting held in the Jefferson Physical Laboratory, Harvard University, Cambridge, U.S., December 14, 1898.

cells, giving approximately twenty thousand volts. This battery charges Leyden jars or Franklin plates, in multiple, and a simple mechanical contrivance enables me to discharge them in series. Thus I have followed the path indicated by Planté; but my experiments have covered a far greater range.

The discharges in ordinary air produced by my apparatus, with a voltage of three millions, are from 6½ feet to 7 feet in length. Prof. Elihu Thomson has obtained discharges of 60 inches by means of transformers. The discharges produced by my apparatus should be at

Fig. 1.

least 10 feet in length; for the relation between spark length and voltage is closely represented by a straight line between the limits of twenty thousand volts and one million volts. This line, however, beyond one million volts, curves towards the axis representing the voltage; and this curvature is an expression of the loss which comes from the rapidly increasing conductivity of the air. This diminishing initial resistance of ordinary air is the most striking fact brought out by my experiments. Before describing the effects of such high electromotive forces, let me speak of the main features of the storage battery. There are, as I have mentioned, ten thousand cells, which consist of ordinary test tubes with corrugated lead strips, which are separated from each other by

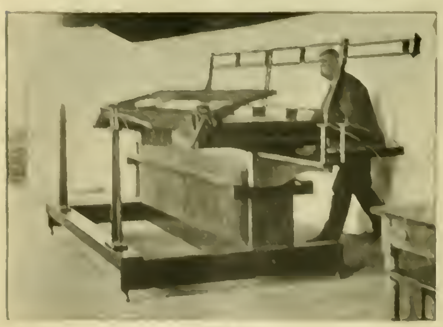


Fig. 2.

rubber bands. These strips are immersed in dilute sulphuric acid; and thus constitute Planté cells. The test tubes are held upright in wooden blocks which have been boiled in paraffin. Lead wires are employed to connect the cells with each other and with the switch-boards. The cells are charged in multiple—forty cells being in each branch circuit—and a system of switches is employed to throw the cells into series. Fig. 1 shows the type of cells.

The construction of the apparatus for charging the Leyden jars in multiple and discharging in series, when high electromotive forces are generated, required a complete departure from the method employed by Planté; and consists, in the main, of a system of levers which obviate short circuiting. Fig. 2 exhibits this apparatus, which, in a certain sense, can be termed a step up condenser. The figure of the operator shows the size of the apparatus, which produces in ordinary air a spark 50 inches in length. A larger apparatus, constructed on a similar plan, enables me to experiment with discharges 6½ to 7 feet in length.

I wish, especially, to call attention to the results obtained with this latter more powerful apparatus, which gives an

Fig. 3.

electrical tension of three million volts. At this tension, atmospheric air at ordinary pressure behaves like a fairly good conductor, and exhibits an initial resistance of less than a thousand ohms between pointed terminals five or six inches apart. Resistances of distilled water, or of ordinary city water, contained in glass tubes, of length not exceeding six or seven feet, cannot be employed; for a spark passes inside the tubes close to the walls—presumably through a layer of air—and the heated air shatters the tubes. The spark will pass fifteen or more inches over the surface of water, in preference to passing the same distance through it. Fig. 3 is a photograph of such a spark passing over the surface of water. The terminals of the machine were immersed in the water, fifteen inches apart. The photograph shows the reflection

Fig. 4.

of the spark from the surface of the water, and thus gives two views, so to speak, of different sides of the spark. No ribbon effect is observable, and an absence of a zigzag path is noticeable.

A peculiar striated appearance is seen in photographs of the brush discharge from the positive pole. Fig. 4 shows this stratification. The pole consisted of a metallic sphere one foot in diameter. Fig. 5 exhibits the brush discharge from the negative pole. In both cases these are photographs of single discharges, which are thus seen to consist both of forked white discharges,

like lightning discharges, and numerous brush discharges, which fill the air between the terminals.

It seemed an interesting question to ascertain whether the spectrum of atmospheric air obtained by means of the great electromotive force of three million volts would show more lines than are produced by lower voltages. Photographs were therefore taken between brass terminals of the spectrum produced by the spark; and comparison spectra between zinc and copper terminals were obtained by means of the spark of a transformer giving about one hundred thousand volts, with large

FIG. 5.

quantity of electricity. The characteristic atmospheric lines can be seen common to the three spectra. The photograph, however, of the spark produced by three million volts (A, Fig. 6) shows an absence of metallic lines, and must closely resemble, I believe, the spectrum of lightning. The photographs were taken by means of a Browning direct vision spectroscope, on orthochromatic plates, which were sensitive from the D line to the neighbourhood of the H lines. It is interesting to discover that no new lines apparently come out by the employment of very high electromotive force.

FIG. 6.

The condensers of the apparatus, which develops three million volts, were at first raised only six inches above the floor. When the room was darkened, luminous discharges were observed, which passed from the edges of the condensers to the floor. The condensers were then lifted to a height of three feet: these brush discharges were much lessened, and the length of the electrical discharges between the terminals was increased. There was still considerable loss; for sparks could be drawn from the neighbouring gas-pipes, and even from the brick walls. In order to obtain discharges in ordinary air of greater length than seven feet, by the employment of three million volts, the entire apparatus should be lifted to a considerable height above the earth, and should be remote from neighbouring objects.

The inductive effect of such high tension extends to a remarkable distance. Photographic plates contained in ordinary holders, held six to ten feet from the terminals of the apparatus, show on development arborescent figures, evidently caused by inductive electrical discharges. X ray photographs of the skeleton of the hand can be taken by a single discharge passing through a Crookes' tube. The tube, however, is spoiled in the operation. The discharge will penetrate a space so highly rarefied that an eight-inch spark from a powerful Ruhmkorff coil cannot pass through it. If a Crookes' tube could be constructed which would resist the destructive effect of the discharge, great penetrating effect could undoubtedly be obtained.

NOTES.

THE new Session of Parliament was opened on Tuesday with the customary formalities. The legislative plans of the Government include, as stated in the Speech from the Throne to the Commons, "a measure for the establishment of a Board for the administration of primary, secondary, and technical education in England and Wales."

AT the last meeting of the Institution of Electrical Engineers, Lord Kelvin was elected an honorary member of the Institution. Lord Kelvin is the oldest surviving past president of the Institution, having held the office of president in 1874, when it was the Society of Telegraph Engineers, and again in 1889, which was the first year after the society had received the designation that it now bears.

IT is reported that the Russian Government contemplates sending an expedition to Samarkand and Merv, to investigate and report upon the recent outbreaks of malarial fever which have greatly alarmed the inhabitants of those districts.

WE learn from *Science* that the sculptor Herr Ernst Herter has completed the statue of von Helmholtz, which is to be erected in the court of the University of Berlin, between the statues of the two Humboldts. The monument will be unveiled in the spring.

M. ROUX has been elected a member of the Section of Rural Economy of the Paris Academy of Sciences, in succession to the late M. Aimé Girard.

M. E. A. MARTEL, general secretary of the Paris Société de spéléologie, has been awarded the grand medal of honour of the Société de topographie.

PROF. PERCY FRANKLAND, F.R.S., has been elected president of the Physics, Chemistry, and Biology Section of the Sanitary Institute, for the congress to be held in Southampton in August next.

THE Earl of Rosse will give an address upon the heat of the moon, at the Camera Club this evening.

THE annual general meeting of the Royal Horticultural Society will be held on Tuesday next, February 14. The annual meeting of the Royal Photographic Society will also be held on the same day.

THE annual general meeting of the Malacological Society will be held to-morrow (Friday), and a presidential address will be delivered by Lieut.-Colonel H. H. Godwin-Austen, F.R.S.

THE death is announced of Major J. Hotchkiss, who in 1895 was president of the Section of Geology of the American Association for the Advancement of Science, and was the author of a number of papers on economic geology and engineering.

THE annual meeting of the Institution of Naval Architects will take place on Wednesday, March 22, and the two following days, at the Society of Arts. The Right Hon. the Earl of Hopetoun, G.C.M.G., president, will occupy the chair.

COLONEL EDMOND BAINBRIDGE, C.B., Royal Artillery, Superintendent of the Royal Laboratory, Woolwich, has been appointed to succeed the late Sir William Anderson, K.C.B., as head of the Ordnance Factories.

Malpighia records the death of two distinguished Italian botanists, Prof. T. Caruel, director of the Museum of the Botanical Garden at Florence, a copious writer on many branches of botany; and Dr. G. Gibelli, Professor of Botany at Turin.

MR. ASA VAN WORMER (says the *American Naturalist*), a wealthy merchant of Cincinnati, has presented the sum of 56,000 dollars to the University of Cincinnati, for the erection of a fire-proof library.

Cosmos for January 28 contains an article by M. Larbalétrier, giving an account of the cultivation of the truffle in France, with a table showing the importations and exportations for the years 1895–1897. During the year 1897 France exported 193,376 kil. of truffles, valued at 1,740,380 francs; of these, 86,000 kil. came to this country. A map shows the areas both of the natural production and of the cultivation of the esculent. With the exception of the culture in the neighbourhood of Paris, these are entirely in the southern and, especially, in the south-eastern departments.

IT is announced, by the *Geographical Journal*, that considerable progress has been made with the preparation, for publication, of the extensive scientific material collected during the voyage of the *Fram*, and that there is a likelihood that the first volume of memoirs will be issued during the coming summer or autumn. The collection will be in quarto form, and the separate memoirs will be the work of a number of specialists in the subjects treated of, each being paged separately. The total number will probably be about twenty, forming from three to five volumes. The memoirs will be published at the expense of the Nansen Fund for the advancement of science.

AN effort is being made to introduce into this country the Nodon-Bretonneau method for seasoning wood by means of electricity. Upon this system the timber to be seasoned is placed in a large tank and immersed, all but an inch or two, in a solution containing 10 per cent. of borax, 5 of resin, and 0·75 of carbonate of soda. The lead plate upon which it rests is connected to the positive pole of a dynamo, and the negative pole being attached to a similar plate arranged on its upper surface so as to give good electrical contact, the circuit is completed through the wood. Under the influence of the current the sap appears to rise to the surface of the bath, while the aseptic borax and resin solution takes its place in the pores of the wood. This part of the process requires from five to eight hours for its completion, and then the wood is removed and dried either by artificial or natural means. In the latter case a fortnight's exposure in summer weather is said to render it as well-seasoned as storage in the usual way for five years.

THE *British Medical Journal* publishes the following statement:—A somewhat mysterious communication was made last week to the Académie de Médecine. It was to the effect that M. Jaubert, who is a chemist formerly attached to the École Polytechnique, had succeeded in finding a substance which, when used in proper proportion, was capable of removing from the air of a closed chamber the carbonic acid, watery vapour, and other irrespirable products produced by a living animal enclosed in the chamber, while at the same time giving out "automatically in exchange the mathematically exact quantity of oxygen required." Two experiments were made by Dr. Laborde, the one on a guinea-pig under a bell jar, the other on M. Jaubert's brother, who wore a tightly-fitted respiratory mask. The nature of the substance is not mentioned, the only indication being that it is the lightest "reservoir" of oxygen in existence. The note is published only to obtain priority for the discoverer; but we are told that the research has been in progress since May last, with the approval and assistance of the French Ministry of the Marine, which was interested in M. Jaubert's scheme because it promised to be useful in submarine boats and in diving-bells. It is stated that three or four kilograms of this substance is enough to keep a healthy adult alive for twenty-four hours in a space hermetically closed. M. Laborde thinks that the substance will be of use also in medicine, since a few grams—an amount which can be easily carried in a waistcoat pocket—would at once yield several decalitres of very pure oxygen gas.

THE *British Food Journal and Analytical Review* is the title of a new monthly publication, which has for its object the discussion of all matters of general interest connected with adulteration and fraudulent trading. Arrangements have been made whereby the British Analytical Control will have this journal as its press organ. For the enlightenment of those who do not know what is meant by the "British Analytical Control," we are informed that it is a system of permanent control and guarantee in relation to food products and to other articles of public necessity and utility, which has been established in Great Britain and the Colonies and Dependencies of the Crown. There can be no doubt that such an association, established as it is with the approval and co-operation of a number of leading public analysts and other scientific men, is capable of doing most useful work in bringing public opinion to bear upon this important subject.

A RECENT number of the *Centralblatt für Bakteriologie* contains a paper on the vitality of the typhoid bacillus in milk and butter, by Messrs. Bolley and Field, of the Government Experiment Station for North Dakota, U.S.A. The butter used in these investigations was derived from an ordinary creamery, and contained one ounce of salt per pound. Ten days appears to be the longest period of time over which typhoid bacilli introduced direct into butter could be detected. When, however, the cream was infected with typhoid germs before churning, the latter were discovered in butter even after three months. Typhoid bacilli do not apparently make any marked growth in butter if the butter-milk is thoroughly worked out of it; if, however, the latter is left in to any extent, the bacilli take advantage of the mixture and multiply. In sterilised milk typhoid bacteria can exist for upwards of four months, and, inoculated into ordinary milk freshly drawn, they have been demonstrated as long as three months. No types of bacteria were met with in milk which proved capable of overcoming the typhoid bacillus; even when inoculated in comparatively small quantities into sour milk, it took well-nigh complete possession of the liquid becoming almost a pure culture. These experiments furnish yet another warning, to those concerned with the conduct of our dairy supplies, of the supreme importance of vigilance in all matters connected with the manufacture and distribution of such easily-infected articles of food as milk and butter.

THE *Journal* of Grahamstown (Cape of Good Hope) refers to an interesting return published by the Department for Agriculture, showing the ravages of rinderpest in the Cape Colony, and the results of the highly creditable battle waged against it by our officials. From it we learn that the proportion of cattle infected (including those inoculated) was 98 per cent. of the

whole; the number that perished were 35 per cent., and those saved were 65 per cent. Various systems of inoculation were used, as that of Dr. Koch, the improved method elaborated by Dr. Edington, and the process of Drs. Turner and Kolle. In some districts all three were in operation. In twenty-three districts, as shown by the printed returns, 393,777 head of cattle were inoculated under Dr. Edington's system, the resultant mortality being 32,464, or only 8¼ per cent. Thus more than 360,000 cattle were saved, or over *two millions sterling* in value, by the application of the glycerinated bile process.

WE are glad to notice, from a short report by Mr. Alex. Meek, that the Northumberland Sea Fisheries Committee has established some connection with the Durham College of Science, and that a certain amount of scientific work is now being carried on in the marine laboratory at Cullercoats. The report is chiefly occupied with the results of the trawling expeditions carried on in the summer of 1898 by Mr. John Dent in the steamer *Livingstone*. The hauls seem to have been comparatively few in number—probably too few as yet in each year to justify any conclusions drawn from the curves given. The report ends with an interesting account of the mussel cultivation carried on by Major Browne at Budle Bay, on the Northumberland coast. As the fishing boats of the neighbourhood require about 1500 tons annually for bait, and as all of this, with the exception of 200 tons supplied by the Budle Bay farm, has to be imported from a distance, it seems as if mussel culture on the Northumberland coast ought to be an industry with a future before it.

INVESTIGATIONS carried on by the New York State Museum and the U.S. Fish Commission, lead Mr. T. H. Bean to conclude that marine fishes now certainly known in the New York fauna represent 200 species. The fresh waters contain 116 species, and there are, besides, thirteen anadromous forms. The list might be further increased by the addition of nineteen, including forms doubtfully assigned to the fauna, which would bring the total up to 348 species. Mr. Bean remarks that no systematic account of the fishes has been published since 1842, and many large regions of the State are almost, or altogether, unknown to the ichthyologist.

COMMENTING upon photographs of ribbon lightning obtained by the Rev. J. Stewart-Smith, in the U.S. *Monthly Weather Review*, Prof. Cleveland Abbe remarks that they are not taken by moving the camera during exposure. He points out that a discharge of lightning is too fleeting to be influenced by the motion of the camera. With artificial oscillatory discharges one may so control the time of the discharges and the motion of the sensitive film as to produce the appearance of a ribbon; but no motion of the camera seems likely to explain the many details in these ribbon photographs of natural lightning. On the contrary, Prof. Abbe thinks there is one flash on Mr. Stewart-Smith's plate that has every indication of being certainly an oscillatory discharge, showing lines of flow identical with those photographed by Prof. Trowbridge at Cambridge, Massachusetts, and fully maintaining his conclusion, which was also that of Prof. Joseph Henry and J. Ogden Rood, that the lightning flash is an oscillatory discharge, repeated frequently to and fro within the crack in the air that is opened by the first discharge. The whole process requires but a few millionths of a second, and the motion of the camera within that short time is insignificant.

WE have received from the Government Astronomer of New South Wales a copy of the "Results of Rain, River and Evaporation Observations" made in that Colony during 1897, containing monthly and annual totals of rainfall at 1518 stations, and the annual rainfall at all stations with three and up to fourteen years' records, with much other useful information, and accompanied by maps showing the tabular results very clearly at a glance. This system, under the careful superintendence of Mr. Russell, has become one of the most perfect that exists, and it is satisfactory to find that the author is able to state that the importance of the work is being recognised every year by a wider circle; no less than 1450 of the observers being volunteers. The average rainfall for the whole Colony during 1897 was 18·89 inches, being 25 per cent. less than the average for the previous twenty-four years. In the catchment of the river Darling the average was 19·75 inches, and in that of the Murray 17·77 inches. In parts of the Colony, there has been an abundance of rain; in others, the intensity of drought.

DR. PAUL BERGHOLZ has sent us a translation into the German language of the late Father B. Viñes' paper entitled "Investigation of the cyclonic circulation and the translatory movement of West Indian hurricanes." The original work was in Spanish, and was translated into English by Dr. C. Finley, of Havana, for presentation to the Meteorological Congress held at Chicago in August 1893. It was recently published by the U.S. Weather Bureau, and briefly noticed in our columns. The investigation is held in such high esteem, as probably the most satisfactory statement of the laws and phenomena of these storms which has yet been made, that Dr. Bergholz has rendered good service to the science of meteorology in preparing an independent translation for the use of German readers. He has also carefully revised it, and rendered it more useful by the publication of several charts showing the zones of the tracks of the storms in the various months. The translation appears in the *Marine-Rundschau*, 1898.

THE Italian Central Meteorological Office is apparently reducing the extent of its publications—not that the number of observing stations is decreasing, for in the last published *Annali*, for 1896, Part ii., they reach 392; but that only ten-day, monthly and annual means are given for temperature and rainfall, together with summaries of the general state of the weather. These results are arranged according to provinces, and in the alphabetical order of the stations. A separate volume of the *Annali* (Part i.) contains, in the same way as in the French Service, some valuable discussions of the detailed observations, including earthquake phenomena. The last published part of this series (for 1895) contains a discussion of the observations of the meteorological observatory on Mount Etna, situated at 2942 metres above sea-level.

THE Geological Survey of Western Australia has issued a *Bulletin* (No. 2) containing two reports by Mr. R. Neil Smith. The first relates to the state of mining in the Kimberley district, and in it the author points out that very little work has been done, except in a few mines, since 1891. The gold-field is evidently not suitable for large companies, but simply for the gaining of a precarious living by working miners. Patches of alluvial gold, and small veins of uncertain continuance, are found at rare intervals, and these may pay well for a few months. The second report deals with the question of obtaining artesian water between the Pilbarra gold-fields and the Great Desert, and the author concludes that the comparatively small superficial extent of the impervious ranges, and the thinness and probable want of continuity of the water-bearing strata, are unfavourable to any system of artesian wells.

QUARTZ mining in Victoria, Australia, is now being carried on in a very economical manner. The methods of mining the stone underground and bringing it to the surface have been reduced to a science, and it is probably nowhere more economically done than in Victoria. There is much room for improvement, though, in the method of milling the ore. The half-yearly statements of several of the public companies,

recently issued, give interesting details, and show what can be done by systematic and careful management. It is said that anything over 3 dwts. to the ton would be regarded as comparatively rich. One company crushed for the half-year 6900 tons for 911 ozs. 1 dwt. of gold, an average of 2 dwts. 15 grs. per ton. This gave a profit on actual working expenses of 1030*l.* 17*s.* 1*d.* The cost of treating the stone had been only 6*s.* 9*d.* per ton, against 7*s.* $0\frac{3}{4}$*d.* the previous half-year.

FROM the Geological Survey of Queensland we have received a copy of *Bulletin* No. 10, comprising "Six Reports on the Geological Features of part of the district to be traversed by the proposed Transcontinental Railway," by Mr. Robert L. Jack, Government Geologist. These Reports were issued in a Parliamentary paper in 1885, and with an appendix consisting of a list of fossils named by Dr. H. Woodward and Mr. R. Etheridge, jun.; but, having for some time been out of print, the Reports have now been reprinted with notes and additions. They deal chiefly with the gold-mining and copper-mining of the Western Downs, and the Cloncurry and Leichhardt districts. We have received also *Bulletin* No. 8, a "Report on the Gold Mines at the Fanning and Mount Success, 1898," by Mr. W. H. Rands, Assistant Government Geologist. The Far Fanning has been worked for many years past in a desultory fashion, but last year some increased activity took place. Mr. Rands, however, reports that there is a great lack of really *bonâ fide* work; the deposits are worked irregularly, and the smallness of the crushings, compared with the large faces of so-called crushing material, shows that a system of working which consists in picking out the best stone has been largely carried on.

SOME interesting observations on the hibernation of ants are described by Miss Theodora Smith in the *Halifax Naturalist*—the organ of the Halifax Scientific Society. Miss Smith had a nest of *Myrmica scabrinodis*, and she placed it in a cold room (in an empty house), where the temperature was about equal to that of the outside air. Under the nest she placed two artificial nests, one of soil and moss, and the other of pure yellow clay—the latter being at the bottom. The combination of nests thus resembled the natural order of things. Observations of the behaviour of the ants under different conditions of temperature showed that the ants went into the clay soil nest for warmth—that is, when the weather was cold—but usually preferred to remain in the mossy black soil when warm enough for them to do so. Miss Smith points out that though in the summer and spring months the young are separated according to size; *i.e.* the eggs are placed in one chamber, the small larvæ in another, those a little larger in another, while the nymph larvæ are separated entirely from the rest, in the winter this division of the relative sizes is not found, all the larvæ, of whatever size, being placed together in an inner chamber. It is suggested that this may be for warmth, and it may be that the young do not require the special attention given to them during more active times of growth.

UNDER the auspices of the British Fire Prevention Committee a detailed report has been brought out by Messrs. Gustave Kaufman, Emil Swensson, and F. L. Garlinghouse, on the Horne Building Fire, of Pittsburgh, U.S.A., which, in approximately two hours from the time of discovery, destroyed three large buildings on opposite sides of Penn Avenue, while damaging half a dozen smaller adjacent structures. An examination of the damage done has led the Board to draw the following conclusions: (1) In buildings of about this height (roughly 115 feet), the distortion of the steel framework, due to the heat of the fire, cannot be sufficient to work any serious damage, nor is it probable that at any time would connection rivets be sheared off. This conclusion is arrived at for the reason that there is no probability that any future fire will be fiercer than the one at issue. (2) The method of fastening fire-proofing to the underside of beams with sheet-iron strips should be discarded. (3) It cannot be too often reiterated that open front buildings like this should be protected from external fires by metal shutters, and also that all shafts should be provided with metal doors which can be readily closed at all floors. (4) The most important lesson taught by this fire was the lack of strength developed by the fire-clay proofing. The building was permitted to move in any direction without any material restrictions by the fire-proofing. The floor arches showed by the scaling off of the lower webs that they were unable to offer any sufficient force to counteract the tendency to lateral motion. (5) The column protection, although composed of the very best obtainable kind of fire-clay tile, was not of sufficient strength. The authors strongly advocate the use of first-class concrete as a fire-resisting material for encasing the columns, girders, and other steel constructions.

REGARDING "soul" as the highest intellectual faculties, Dr. D. G. Brinton refers in *Science* to Dr. C. Clapham's arguments as to its position in the body. Savages believe that the "soul" is in the liver or the heart; cynics suggest that it is in the stomach; phrenologists regard the front part of the brain as the seat of intellect; but the most advanced physiologists are now inclined to teach that the posterior cerebral lobes have the highest intellectual value. In connection with this view, Dr. Clapham has pointed out that man has the most highly developed posterior lobes, and this is conspicuous in men of marked ability and in the highest races. In idiots the lobes are imperfectly developed, and in chronic dementia these portions of the brain reveal frequent lesions.

MESSRS. R. FRIEDLÄNDER AND SON, Berlin, have just issued a classified catalogue of physical books, papers, and periodicals which they have for sale.

MESSRS. H. T. SOPPITT and C. Crossland give, in the *Yorkshire Naturalist* for January, a list of seven new British Fungi found in West Yorkshire, including one new to science, *Saccolabus granulospermus.*

AN address on "Medicine in the Nineteenth Century," delivered by Prof. Clifford Allbutt before the Johns Hopkins University, Baltimore, in October last, is printed in the *Bulletin* of the Johns Hopkins Hospital.

THE twenty-ninth annual report of the Wellington College Natural Science Society has been received. It comprises abstracts of addresses delivered before the Society, meteorological records, and brief references to the work of the members of the various sections.

AN illustrated article on the Natural History Museum at South Kensington is contributed to *Naturen*—an illustrated monthly magazine of popular natural history—by the editor, Dr. J. Brunchorst. The article is one of a series on museums. *Naturen* is published at Bergen, by John Grieg.

A VALUABLE paper upon the origin and history of white and so-called wild cattle is contributed to the *Transactions* of the Natural History Society of Glasgow (vol. v. new series, 1897–98), by Mr. R. Hedger Wallace. Among other papers is one by Mr. G. F. Scott-Elliot, on limits to the range of plant species.

MR. H. LING ROTH contributes some interesting notes on Benin customs to the *Internationales Archiv fur Ethnographie* (vol. xi. 1898). The notes are based upon information given by officials of the lately-deposed King of Benin, and a comparison is made between the statements of the court officials and the records of early chroniclers. Another paper by Mr. Ling Roth, on primitive art from Benin, appeared in *The Studio* in December 1898.

THE Trustees of the British Museum have published the first volume of the monograph of the *Lepidoptera Phalaenae* which they have in preparation. The volume is a "Catalogue of the *Syntomidae* in the British Museum," by Sir George F. Hampson, Bart. In addition to the numerous species of *Syntomidae* in the British Museum Collection, other rich collections have been lent for examination. Coloured illustrations of new or hitherto inadequately figured species are published separately, in order not to add to the cost of the catalogue.

Bulletin vol. iii. No. 5 (October 1898) of the College of Agriculture of the Imperial University of Tokyo, now published entirely in English, is mainly devoted to the discussion of various questions connected with the cultivation of rice. It contains, besides, papers on the formation of proteids and the assimilation of nitrates by phancrogams in the absence of light, by Prof. Suzuki; and on the properties of cocoons of the various silkworm races of Japan, by Prof. Kawara.

THE Hull Scientific and Field Naturalists' Club has just issued the first number of a series of annual *Transactions*, containing papers brought before the members at the fortnightly meetings. It is intended to publish original papers and notes upon local natural history; and if every local society of naturalists did the same, and placed their observations on record, much valuable scientific material would be accumulated.

A READY means of obtaining a number of copies of an illustration is so often required in the scientific world that many men of science will be glad to have their attention called to an appliance called the Photo-Autocopyist, which enables this to be done. The apparatus and method are very simple, but a little experience is necessary to produce good effects. The negative of which copies are wanted is printed in the usual way upon a stout paper having a gelatine surface, which has been previously sensitised by immersion for a few minutes in a 3 per cent. solution of bichromate of potash, and then dried. The gelatinised sheet is taken from the frame when sufficiently printed and washed. It then constitutes the printing surface, which is stretched upon a frame, and inked with an ink roller, the ink only adhering to the indented parts which have been acted upon through the negative. Ordinary paper is then placed upon the inked surface, pressed in a copying press, and taken out at once. A finished, permanent, print is thus obtained in a minute or two, and to procure others it is only necessary to ink the surface again and put it under the press with another sheet of paper. The process is a simple modification of the Collotype method of reproduction, and as a means of quickly obtaining permanent prints from photographic negatives it should prove extremely useful.

SEVERAL new editions of well-known works have reached us during the past few days. The second edition of Prof. W. C. Unwin's "Testing of Materials of Construction" (a text-book for the engineering laboratory, and a collection of the results of experiment) has come from Messrs. Longmans, Green, and Co.—Pages 273 to 672 of the English version (third edition) of Carl Busley's "Marine Steam Engine," translated by Mr. H. A. B. Cole, have been published by Messrs. Lipsius and Tischer, Kiel and Leipzig (London: H. Grevel and Co.), with an atlas containing plates 9-45. It is expected that the third (and concluding) part, consisting of only a few sheets and plates, will be published in the course of the present year. The completed work will be a manual and book of reference for all who are concerned with steam navigation.—Under the title "An Intermediate Text-book of Geology," Messrs. W. Blackwood and Sons have published a text book by Prof. C. Lapworth, founded upon Page's "Introductory Text-book of Geology." With the latter title, the work passed through twelve editions, several of which were prepared by Prof. Lapworth, and in its new form it should be even more successful. The text has been rewritten, with the exception of a few parts, and nearly a hundred pages have been added. Special attention has been paid to the subject of the geographical distribution of the geological formations at home and abroad. Systematic students of geology will find the new volume very serviceable.—A third edition of "Gordon in Central Africa, 1874-1879," edited by Dr. G. Birkbeck Hill, has been published by Messrs. Macmillan and Co., Ltd.

A SERIES of tables, showing the differences between Greenwich mean time and the civil times used in various parts of the world, compiled by Prof. John Milne, F.R.S., is published in the February number of the *Geographical Journal*. The names of places in the tables are arranged in alphabetical order, and the amount by which the time used at each is fast or slow of Greenwich mean time is indicated. Some of the descriptive notes are interesting. It is pointed out that the Chinese at most places use an approximate apparent solar time, obtained from sun-dials. At Tientsin the civil time is determined by the municipal chronometer, which, however, has sometimes been known to have an error of three minutes. The Persians keep sun time, watches being set at sunset. In Teheran there is a midday gun fired by the time shown on a sun-dial. But a few minutes makes no difference in Persia; the railway trains start when full or when required, and Persian telegraphists do not give time of issue or receipt of telegrams.

THE constancy of composition of natural gas is a question of some practical importance to manufacturers in the Pittsburgh region, and as the opinion has been frequently expressed that natural gas fluctuates in its heating power, it seemed worth while to see if these changes in composition really occur. The results of an investigation by Mr. F. C. Phillips on this subject are given in the *Proceedings* of the American Academy of Arts and Sciences for November 1898. Since the nitrogen in the gas appeared to be the most readily determined constituent, attention was first directed to this element, and an apparatus devised by which comparatively large quantities of the gas could be completely burnt by red-hot copper oxide, and the residual nitrogen collected and measured. The results of duplicate determinations on the same sample of gas were closely concordant, the variations not exceeding in any case 0·03 per cent.; but since samples of gas from the same well, collected at different times, showed variations of nearly 2 per cent., it would appear that fluctuations in the composition of natural gas do really occur.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mrs. Emily Price; a Bonnet Monkey (*Macacus sinicus*, ♂) from India, presented by Miss May Wieland; a Sooty Mangabey (*Cercocebus fuliginosus*, ♂) from West Africa, presented by Mr. B. Stewart; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, presented by Captain Chas. T. Swain; a Vulpine Phalanger (*Trichosurus vulpecula*, ♀) from Australia, presented by Mr. W. J. Matthews; a Golden-backed Weaver Bird (*Pyromelana aurea*, ♂) from West Africa, presented by Mr. A. F. Wiener; three Common Marmosets (*Hapale jacchus*) from South-east Brazil, a Great Kangaroo (*Macropus giganteus*, ♀), a Great Wallaroo (*Macropus robustus*) from Australia, a West Indian Agouti (*Dasyprocta cristata*) from the West Indies, deposited; two Indian Chevrotains (*Tragulus meminna*) from India, five Sacred Kingfishers (*Halcyon sancta*), four Lace Monitors (*Varanus varius*) from Australia, a Black-throated Diver (*Colymbus arcticus*) from Holland, purchased; a Red Kangaroo (*Macropus rufus*, ♂), five Puff Adders (*Bitis arietans*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET 1898 VII. (CODDINGTON-PAULY).—Mr. C. J. Merfield, of Sydney Observatory, gives an ephemeris of this comet, in *Astronomische Nachrichten* (Bd. 148, No. 3542), as he considers it likely that it will be possible to observe the comet from northern observatories.

1899.	α (app.) h. m. s.	δ (app.) ° ′ ″
Feb. 10	2 18 2	−35 36 44
14	23 11	33 36 25
18	28 16	31 40 50
22	33 17	29 50 0
26	38 15	28 3 48
Mar. 2	43 10	26 22 9
6	48 3	24 44 57
10	52 52	23 12 4
14	2 57 40	−21 43 25

The comet is rapidly moving northwards, passing from near φ Fornacis into Eridanus. It should be looked for soon after sunset, almost due south from Mira Ceti. It is said to be easily visible with an instrument of six inches aperture.

EROS (433).—In *Harvard College Observatory Circular*, No. 37, Prof. E. C. Pickering describes the finding of trails of the planet on thirteen more plates, in addition to those mentioned in the last *Circular*. These plates were exposed during the period 1893–6, and the estimated photographic magnitude varied from 8·2 to 12·5. He lays great stress on the fact that all the photographs which have been found showing the planet have been taken with *doublet* objectives, giving a large field and large relative aperture. The difficulty is enhanced by the variation in the brightness of the planet, as during the last eleven years it has only been brighter than the ninth magnitude for two months.

In *Popular Astronomy*, January 1899, Mr. W. W. Payne brings together the information given in various disconnected articles by several authors. This will prove convenient for many interested in the planet, and unable to find access to the individual papers.

THE SUN'S HEAT.—In the *Astronomische Nachrichten* (Bd. 148, No 3540), Dr. T. J. J. See introduces a new law bearing on the thermodynamics of a contracting gas, and discusses its bearing on the question of the heat of the sun, and also its application to estimating the relative ages of the stars and nebulæ.

The modern theory of the sun's heat is primarily due to Helmholtz, and its conclusions are based on the supposition that the sun's mass is of *homogeneous* density. This Prof. See doubts, and the result of a series of computations for the heat given out by the contraction of a *heterogeneous* mass was the law of temperature he now brings forward. The effect of this unequal density is to lengthen considerably the period heretofore advanced for the duration of the sun as a light- and heat-giving source. Helmholtz's theory indicates that the output of heat for a given change in radius of the contracting mass increases very rapidly as the radius itself becomes small. From this it appears that the greatest amount of heat is produced when the mass has reached its least dimensions and contraction is about to cease.

Discussing the resulting temperature of a mass contracting under its own gravity, the law deduced is: "The absolute temperature of a gaseous star or nebula condensing under its own gravitation varies inversely as the radius of the contracting mass." The curve representing this condition will be recognised as a rectangular hyperbola referred to its asymptotes.

With this idea it would follow that at first when the nebula is infinitely expanded, its temperature is the absolute zero of space, and that this gradually rises to a maximum when the mass has contracted to the smallest radius consistent with the laws of gases. After liquefaction has set in, free contraction is obstructed and finally ceases; the temperature falls, and the body becomes finally invisible.

This is in accord with the idea of the nebulæ being low temperature bodies. As it contracts the production of heat exceeds the radiation, and the temperature rises inversely as the radius decreases.

In this connection Prof. See mentions the curves of Lane for the laws of internal temperature and density of gaseous masses. (*Am. Jour. Sci.*, July 1870.) He illustrates these by the case of the sun, and infers that it is *increasing* in temperature still. The presence of hydrogen in the white stars he reasons in the same manner. While the nebula is yet considerably extended, gravity is small, and all the elements float in the atmosphere without regard to relative atomic weight, and such produce spectra with many substances, as we see in such solar stars as Capella, Arcturus, &c. When the mass is further condensed, the heavier elements are kept relatively lower by the increased gravitation, and hydrogen, the lightest of the elements, is present as the exterior envelope, and hence the simplified spectrum of the Sirian stars.

The phenomenon of variable stars with dark companions is accounted for on this assumption, the two being of the same age but of greatly different masses. In the case of coloured double stars the companion is generally blue or purple, and the large star yellow or red, which again is in accord with this theory.

Taking the present temperature of the sun to be 8000° C., he calculates that the temperature of the central nebula at the time of formation of the earth was less than 40° C.; the earth beginning at this, contracted until it rose to about 2000° C., which is high enough to account for all known geological phenomena. Jupiter and Saturn are considered, on similar grounds, to be still gaseous and increasing in temperature, and though not now self-luminous, may eventually become so. In conclusion, Prof. See suggests that as the nebulæ are at low temperatures many of them may be invisible, although existent. Many nebulæ have been photographed by the ultra-violet light they emit, which are quite invisible in the most powerful telescopes. If this be true, the numerical predominance of stars over nebulæ, visually, is explained, as according to the nebular hypothesis, the two classes of bodies should exist in approximately equal numbers.

THE CONSTITUTION OF THE ELECTRIC SPARK.[1]

WHEN an electric spark passes between metallic electrodes, the spectrum of the metal appears, not only in immediate contact with the electrodes, but stretches often across, from pole to pole. It follows that during the short time of the duration of the spark, the metal vapours must be able to diffuse through measurable distances.

The following investigation was undertaken primarily to measure this velocity of diffusion with the special view of comparing different metals, and different lines of the same metal.

Feddersen published, in the year 1862, an interesting research, in which photographs of sparks passing between different metal poles are taken after reflection from a rotating mirror. He could from his experiments draw some conclusions which have a bearing on the subject, but it was necessary for our purpose that the light should also be sent through a spectroscope, so as to distinguish between the luminous particles of air and those of the metal poles.

The method of the rotating mirror tried during the course of several years in various forms by one of us, did not prove successful. On the other hand, good results were obtained at once on trying the method used by Prof. Dixon, in his researches on explosive waves. This method consists in fixing a photographic film round the rim of a rotating wheel. All that is necessary for its success is to have sparks so powerful that each single one gives a good impression of its spectrum on the film. Were the sparks absolutely instantaneous, the images taken on the rotating wheel would be identical with those developed on a stationary plate, but on trial this is found not to be the case. The metal lines are found to be inclined and curved when the wheel rotates, and their inclination serves to measure the rate of diffusion of the metallic particles. The air lines, on the other hand, remain straight, though slightly widened.

To avoid the tendency of the film to fly off the wheel when fixed round its rim, as in the original form of the apparatus, a spinning disc was constructed for us by the Cambridge Scientific Instrument Company. The film is placed flat against the disc, and is kept in place by a second smaller disc, which can be screwed lightly to the first. The diameters of the two discs are 33 and 22·2 cm., the photographs being taken in the annular space of 10·8 cm., left uncovered by the smaller disc. An electric motor drives the disc, and we have obtained velocities of 170 turns per second, though in our experiments the number of revolutions was generally about 120, giving a linear velocity

[1] By Prof. Arthur Schuster, F.R.S., and G. Hemsalech. Read before the Royal Society February 2.

of about 100 metres/second for that part of the film on which the photograph was taken.

The electric discharges were obtained from a battery of six Leyden jars, having a total capacity of 0·033 microfarad, and being charged from an induction machine constructed for us by Mr. H. C. Wimshurst. This machine has twelve plates of 62 cm. diameter, and gives sparks which are 13 inches long. The electrodes were, as a rule, placed 1 cm. apart, and an image of the spark was projected on the slit of the spectroscope, the distance of the slit from the electrodes being equal to four times the focal length of the projecting lens, so that the image was equal in size to the spark. The prism used was made by Steinheil, and had a refracting angle of 60°.

We may now pass to the description of the results obtained when the spectrum of a single spark is taken on a moving film. A preliminary trial with various metallic electrodes had shown us that the sharpest results were obtained with zinc, and we therefore chose that metal for our first investigation. The principal lines of zinc as they appear on our photographs are the double line, the least refrangible of the two having a wave-length 4924·8, and the blue triplet, the wave-length of the leading line being 4810·7. All the lines are curved on the photographs taken with the spinning disc, but the displacements, especially near the poles, are subject to considerable variations. This is probably due to the fact that the path of the metallic particles is not always straight, and, if straight, its image does not necessarily coincide with the slit. A very slight error in measurement will also affect the results considerably when the total displacement measured is small. Our results do not for this reason allow us at present to give any opinion as to the maximum velocity of the particles near the pole; but if these are considerable, they drop down very quickly to speeds which, in the case of zinc, are not far off 500 metres/second.

We have adopted two methods of comparison between different photographs. We have in the first place measured the displacements at a number of nearly equidistant points, and from these measurements we have deduced the time taken for a metallic molecule to pass from the pole to a point 2 mm. away from it. If this method could be applied in every case, it would form a rational and consistent basis of comparison. But the curved lines which are to be measured are often very diffuse near the pole, this, and the continuous spectrum, may render it impossible to obtain satisfactory measurements at that point. In order not to have to reject unnecessarily a large number of measurements because the spectrum near the pole was indistinct, we have adopted another method, which, though less rational than the first, is found to give consistent results. From all our measurements we may deduce certain figures for the molecular velocities at different and generally equidistant points on the photographs, and may take the average of all these figures as the mean velocity of the particle. In the following tables, V_1 will always refer to the mean velocity between the pole, and a point 2 mm. away from it, while V_2 refers to the average velocity taken for different distances, as just explained. The influence of change of capacity and change in the length of the spark was investigated in the case of zinc, and the following tables exhibit the results. As the zinc lines are sharp near the pole, the first of the above methods of measurement could be applied.

TABLE I.—*Average Velocity* (V_1) *in metres/second of Zinc Molecules.*

Sparking distance.	Wave-length.	Number of jars.		
		2.	4.	6.
cm. 0·51	4925	814	556	416
	4811	1014	668	529
1·03	4925	400	499	415
	4811	501	548	545
1·54	4925	723	1061	435?
	4811	1210	1526	492?

The first striking result to be deduced from the table is the uniformly higher velocity deduced from the double line 4925, as compared with that found when one of the lines of the triplet is measured; for we have ascertained that the two first lines of the triplet are always displaced by the same amount, and the third is so much mixed up with the air lines in its neighbourhood that it cannot be measured. It was one of the objects of the investigation to detect, if possible, differences of this kind, which might be accounted for by the fact that the molecules producing different lines of the same spectrum have not necessarily the same mass. We nevertheless hesitate to ascribe the smaller apparent velocity derived from $\lambda = 4925$ to this reason. This line, as has been mentioned, is one component of a double line, and the doublet is not resolved on the photographs taken with the moving film. Near the pole where the light is strong, the edge of the least refrangible component of the doublet would be considered to be the least refrangible edge of the doublet; but near the centre of the spark the light is weaker, and the lines, owing to the motion of the wheel, are drawn out towards the violet. The most intense portion of the image will here be that part where the two lines are superposed, and, in wishing to set the cross wire on the edge of the line, we should be tempted to set it on the edge of the *most* refrangible component. There is reason to believe that this is the cause of the greater deflection of the double line, and the photographs show some signs that if this source of error is eliminated, the molecule giving out the double line moves more quickly than that giving rise to the triplet. We reserve the decision of this point until we have been able to apply greater dispersion.

Comparing the spark obtained with different capacities, it is found that when the spark gap is small, there seems a very curious *diminution* of velocity as the capacity increases; this is not what should have been expected at first sight, as with the large number of jars we should expect higher temperatures, and therefore greater velocity of diffusion. When the spark gap is 1 cm., the experiments do not reveal any marked change due to capacity. When the gap is increased still further the sparks become very irregular and unsteady, and no certain conclusions can be drawn from our measurements; the numbers marked with a query are specially doubtful. When six jars are used practically identical numbers are obtained for all sparking distances, but with small capacity the centimetre spark seems to give a lower result than in the two other cases. While we should not like at present to consider this as an established result, the table serves to show that the centimetre spark and the highest capacity used gives the most consistent numbers, and our experiments with other metals were all made under these conditions, except in the case of bismuth, where clearer spectra were obtained with only two jars.

Comparing different metals with each other, we find in the first place that those having comparatively low atomic weights, viz. aluminium and magnesium, have higher molecular velocities. With magnesium the metal vapour is scattered about to such an extent that no measurements could be made, but the average velocity of the aluminium molecule was found to be over three times as great as that of zinc, the numbers not laying any claim to accuracy. Comparing zinc and cadmium with each other, we obtain almost identical numbers, both for the corresponding doublet and triplets.

Bismuth gave remarkable results. In spite of its high atomic weight some of the lines are but little displaced, indicating an average molecular velocity of 1420 metres/second. For other lines the velocity falls down to that of zinc and cadmium, while one line ($\lambda = 3793$) has a still smaller velocity.

We have not obtained satisfactory results with mercury; the best were those in which poles used were of zinc or cadmium, which were covered with amalgam. Differences in molecular velocities were obtained for different lines, but the result here is not so certain as with bismuth. There is obviously no simple law connecting these velocities with the atomic weight.

Dr. Feddersen was led through his researches to the conclusion that the metallic particles after being once torn off from the electrodes by the discharge took no further part in it, were thrown irregularly into the space surrounding the electrodes quite independently of the electric current. Although in some cases, and especially with magnesium poles, there is some evidence that this is partly true, we are led to take the following modified view of the matter.

The initial discharge of the jar takes place through the air; it must do so because there is at first no metallic vapour present. The intense heat generated by the electric current volatilises the metal, which then begins to diffuse away from the poles; the

subsequent oscillations of the discharge take place through the metallic vapours, and not through the air. We find confirmation of this view in a striking experiment which is easily repeated. If a coil of wire be inserted in the spark circuit of a Leyden jar, which may be charged either by a Wimshurst machine or an induction coil, the air lines disappear almost completely, the metallic lines alone remaining. According to our view we should explain the experiment by saying that the coil which adds self-induction lengthens the duration of the discharge, and allows time for the metallit molecules to diffuse properly into the spark gap. A great part of the energy of the current may then do useful work by heating up the metallic molecules instead of those of air. Mr. Hemsalech is at present engaged in investigating the changes in the metallic spectra which accompany the insertion of self-induction.

The first spark passing through the air will give rise to a sound wave which, during the complete time of the discharge, will only travel a few millimetres. We may therefore consider that the mass of metallic vapours suddenly set free is driven by its own pressure into the partial vacuum formed by the heated air. It would seem more correct to liken the process to that of a gas under pressure flowing into a vacuum than to that of a pure thermal diffusion. There is not much difference between these views, and we may take it that in our experiment we have approximately measured the velocity of sound in the metallic vapours. This gives a relation between their temperature and density. If we neglect the differences in the ratio of specific heat, we find approximately

$$V = 80 \sqrt{T/\rho},$$

where T is the absolute temperature and ρ the vapour density referred to hydrogen. Thus for cadmium the average molecular velocity found was 560, and substituting $\rho = 56$ we obtain $T = 2700$, which seems a possible value. Hence we conclude that the molecule of cadmium in the spark cannot have a mass which is much smaller than that directly determined near the boiling point of the metal.

In conclusion we have also taken some photographs in which the slit was directly focussed on the sensitive film without the interposition of the film. The photographs show a straight image of the slit followed by a number of curved bands extending from both poles into the spark gap.

The straight image we consider to be the initial discharge through air creating sufficient heat to fill the space with vapour through which the oscillating discharges may then pass. Our experiments point to the fact that the periodic time was rather too small in our experiments to give the best results. The metallic molecule before it has had time to reach through a sufficient distance was possibly affected in its motion by the subsequent oscillation. We hope to remedy this defect by introducing still higher capacities than those used. Our experiments allow us to give the following approximate numerical data. The air rendered luminous by the first discharge remains luminous for a time of about 5×10^{-7} seconds, the metallic vapours then begin to diffuse and reach the centre of the spark (the gap being 1 cm. long) in a time which in the case of cadmium was about 6×10^{-6} seconds. The periodic time of the oscillations with our six jars and a circuit possessing as little self-induction as possible was about 2×10^{-6} seconds. The metallic vapours remain luminous in the centre of the spark for a longer period than near the poles, the duration of the time during which some luminosity can be traced with a discharge from six Leyden jars is about $1 \cdot 5 \times 10^{-5}$ seconds.

MR. BALFOUR AND PROF. JEBB ON TECHNICAL AND SECONDARY EDUCATION.

TWO important speeches on technical and secondary education were made during last week—one by Mr. Balfour in opening a new hall which has been erected in connection with the Battersea Polytechnic, and the other by Prof. Jebb at Cambridge. The *Times* reports of the remarks made on these two occasions are abridged below.

MR. BALFOUR ON TECHNICAL EDUCATION.

Everybody interested in the least in the progress of education must watch with the profoundest interest the great experiment now being carried on in this metropolis, and not the least in the building where I am now addressing you, in connection with technical education. If I understand the matter rightly, the experiment differs from any other efforts in the same direction which have been made, either in this country, in other great centres of population, or on the continent of Europe—in Germany or in Switzerland, or in any other countries which have been pioneers in this matter of scientific and technical education.

Every scheme of education has to be considered from two distinct points of view. We have to consider its effect in qualifying the individual who receives the education for the particular work in life which he has to do. That is the first aspect of it; but there is another aspect not less important, which certainly ought never to be lost sight of, and which is not lost sight of in this institution—namely, the general educational results at which any sound system of education ought to aim. There is the technical side and there is the general side. There is the skill infused in the pupil for following that profession in life which he has selected, or which circumstances have forced upon him; and there is that other and that broader aspect in which all education of every kind is intended to co-operate—namely, the development of the general faculties of mind, eye, and body, and also to make a man or a woman a complete citizen, with all their faculties developed to the highest possible point.

Technical Instruction.

Taking these two aspects in turn, and dealing, in the first instance, with the industrial and technical aspect, I do not feel myself qualified to speak with any authority upon that part of the work of this institution which has to do with handicrafts. I understand that the aim of the institution in this connection is to supply those who are engaged in these handicrafts with more theoretical and general instruction in connection with their special pursuit which is required to enable the people to reach the highest results in that pursuit. I cannot imagine a better object. I am not aware that in other places the same object is pursued systematically and successfully in the same way in which it is pursued in the London polytechnics. After all, it has to be recognised that work is mainly to be learnt in the workshops, and I am convinced that no wise teacher would for a moment attempt to substitute either the lecture-room or experiment-room for that which can be learnt only in the workshop. But unquestionably there are branches of knowledge connected with trades and handicrafts which have a theoretical side which cannot with equal facility be learnt except in a place devoted to that side, and I believe that the work done in this institution in that connection is one of the greatest value, not merely to the pupils, but to the trades and industries which they have elected to follow.

Scientific Education.

But there is another side, and, from a national point of view, perhaps a decidedly more important side than that, and the side I mean is the complete scientific equipment of a student for those professions in which a thorough grounding in science, theoretical and practical, is absolutely necessary if he is to make the most of himself and the most of the profession in which he is engaged. I have always been deeply interested in this aspect of the question, which is the one specially considered in Germany and elsewhere, and the value of which we have perhaps in this country until recent years unduly ignored and neglected. It is an interesting question to ask ourselves how it comes about, and why it comes about, that it is only in the latter half of the nineteenth century that the absolute necessity of this thorough scientific grounding has been recognised in connection with great industrial enterprises. And the real reason I take to be this—that it is only after science has developed to a certain point, and after industry has developed to a certain point, that you can, as it were, successfully and usefully combine the two, and that there is forced upon you the necessity of recognising that almost every advance in theoretical science is reflected in a corresponding advance of industrial enterprise, and in like manner industrial enterprise and the practical application of science is itself from day to day giving birth to new scientific conceptions and new improvements either in the machinery of discovery or in the results of discovery. If anybody wishes to have a concrete illustration of this abstract truth I would ask him to make the following comparison. Take for a moment the career of the greatest man of science that this world has ever seen—I mean Sir Isaac Newson. As far as I know—I speak under correction—neither by Sir Isaac Newton himself, nor by

any one during his lifetime, were any of his epoch making discoveries turned to any practical industrial account. So far as I know neither the unparalleled advances he made in the methods of mathematical investigation nor his discoveries in physics, in the laws of energy and the laws of motion, nor his discoveries in the region of light had any important practical bearing upon the industries either of his own country or any other country during his long life. Those discoveries were, for the most part, made while he was comparatively a young man—made, let me tell the younger members of my audience, at that happy time of life between twenty and thirty when the inventive energies are freshest, and when I hope many of them will be able to add to the store of our knowledge; but though those discoveries were made at this early period, and though Newton lived to a very advanced age, the fact broadly, I believe, is that his inventions had no important effect upon the industrial world. Now, compare with the career of Newton the careers of two of the greatest men of science that we have seen in our time—Pasteur and Lord Kelvin—two of the greatest names, I was going to say, in the science of all time, but certainly in the science of the last half of the nineteenth century. Almost every discovery of those two great men found its immediate echo in some practical advantage to the industrial world. It would be a mere impertinence before an audience in which there are many persons incomparably more qualified than I am to speak on those subjects, to dwell upon the details, but the fact is familiar to almost everybody, and the extraordinary additions which both these great men have made in very different spheres to our theoretic knowledge have had an application of incalculable value, either in the department of commercial production, of navigation, or of medicine and therapeutics.

A Plea for Thoroughness.

Can you have a more instructive contrast than I have endeavoured to lay before you between the immediate results of the scientific career of Newton and the scientific career of two of Newton's great successors, and on what does it depend? It depends upon this, that theoretical science and practical production have each on their sides now so advanced, come so close together, are so intertwined, that nothing can happen in one branch which has not its copy in another branch. Theory and practice are now almost different sides of the same shield, and he who advances theory knows probably in his own experience that it will be met in practice, and he who advances practice may rest assured that some of the fruits of his labour will be found valuable to theory. In order to obtain the highest results which we hope may really follow from such training as students obtain in the higher and more difficult branches of science in institutions like this it is absolutely necessary that the training should be thorough. It is absolutely necessary if we in this country are to compete on equal terms with the scientifically trained pupils of foreign polytechnics that the scientific training here must be offered and must be taken—and I believe it to be taken by the pupils here—in the same spirit in which it is taken in Germany or in Switzerland. Whatever else may be said of the system of education there—and do not suppose that I for one hold it up as being superior in every respect to what we have in this country—at all events, the sternest critics must admit that it is thorough in the branches with which it deals; and the man who has got the best out of one highly equipped foreign place of technical instruction does really know not merely the theoretical groundwork, but the whole special detail of the science most nearly concerned with his work in life. That thoroughness is aimed at, and I believe is attained in this institution; and it is for that reason I look forward with such great confidence to the results of the system of education here instituted in its higher branches. For it is the higher branches, mark you, that ought to be on a universal level. Part of the work of a polytechnic is more properly described as secondary education. Part of it must be more than secondary education; and if we fall short of the highest ideal of all we fall short of something which is, I believe, absolutely necessary both from an educational and from a technical point of view.

The General Aspect of Education.

It remains for me to say a word upon the second and more general aspect of education.

I feel that even those students of this institution who come here merely to gain some addition to their knowledge of a special handicraft may carry away something which is of far more importance to them than the mere acquisition of technical skill They may carry away that broadened knowledge of the laws of nature and the progress of science which, to my mind, is not less liberalising and of not less value in the highest sense of education than the most accurate knowledge of the grammar of a dead language or the works of an ancient civilisation. I make no attack, I need hardly say, on literary education, but I cannot admit that scientific education even if it be humble in its amount, if it be stopped comparatively early in the career of the learner—is not capable of producing as beneficial educational effects on the taught as any system of education which the ingenuity of the world as has yet succeeded in devising. Let me conclude by saying that I value the great privilege of being asked to take a leading part in this interesting ceremony. I believe that the polytechnic is doing a great work, not merely for the economic, but for the educational future of the country. I believe that in that work this splendid building, which we owe entirely to the liberality of private donors and of liberal companies, is destined in future to play no small part in the lives of those who come to this institution for educational advantages which until twenty years ago were not within the reach of any citizen of this great city.

PROF. JEBB ON SECONDARY EDUCATION.

A meeting of members of the University of Cambridge was held at Trinity College Lodge on Saturday afternoon to consider prospective legislation with regard to secondary education.

Prof. Jebb, M.P., moved the following resolutions: (1) "That this meeting welcomes the Board of Education Bill introduced by the Duke of Devonshire in the House of Lords last August as an important step towards the organisation of secondary education in England." (2) "That, in the opinion of this meeting, the consultative committee proposed in Clause 3 of the Bill should be made permanent, and should contain representatives of the Universities and of the teaching profession." (3) "That, in the opinion of this meeting, it is desirable that a system of inspection and examination conducted by a University, and approved for the purpose by the Board of Education, should be accepted as adequate under Clause 2, section (4) of the Bill." (4) "That copies of resolutions 1, 2 and 3 be forwarded to the Marquis of Salisbury, the Duke of Devonshire, Mr. Balfour, and Sir John Gorst." Speaking to the first proposition Prof. Jebb, in the course of his remarks, said:—

Scope of the Board of Education Bill.

The first duty of a recognised central department will be to take something in the nature of a census or a general survey of our existing educational resources. Such a survey was necessary, because at present, owing to the number of separate and independent agencies at work, there was no means of ascertaining precisely where gaps and deficiencies existed, and where, on the other hand, power was being wasted—though the existence of such evils was sufficiently manifest. The central authority, overlooking the whole field, would be able to determine what parts of the ground were vacant and in what parts of it there was overlapping, and therefore loss of power. The scope of the Bill, confined as it was to setting up a central authority, was limited. He believed this limitation to be a wise one, not merely on Parliamentary grounds, because such a Bill was easier to get through both Houses, but on larger grounds of educational policy. The establishment of a strong central authority, commanding public confidence, would in itself facilitate the creation of local authorities of a satisfactory kind; it would tend towards harmony among the various agencies and interests which claimed representation in the local management of secondary education. Further, the preliminary stock-taking by the central authority of our educational resources—that general survey or census to which he had just referred—was an operation which might with great advantage be performed, or at least begun, before the new local authorities came into active operation, since it would in some respects facilitate their task, and give them the advantage of information which no one of them separately could collect with equal efficiency or comprehensiveness. But there should be no mistake about the fact that the Government, speaking by the mouth of the Lord President on August 1, had clearly recognised the necessity of creating new statutory local authorities for secondary education, and regarded that as the next step to be

taken. Dr. Jebb next touched upon the uneasiness caused in some quarters by Clause 7 in the revised Directory of the Science and Art Department, issued in 1897, and said a needless fear had arisen lest the clause was designed to forestall the establishment of local authorities by Parliament and to set up voluntary organisations in their place. It was a "temporary and partial expedient." After what the Lord President had said he might say that they had the most explicit and the most completely satisfactory assurances that the Government contemplated following up their creation of a central authority by the creation of local authorities, and that it would be altogether unjustifiable to refuse a welcome to the Board of Education Bill on the ground that its own immediate scope was limited. With regard to the second proposition, Dr. Jebb addressed himself to the desirability of the Consultative Committee of the Board of Education being of a permanent character. They desired that, if not a statutory body, it should, at all events, be a recognised institution, not a merely occasional resource, which might or might not be called into existence by the Minister of the time. In asking for some express recognition of the Universities and the teachers on the Consultative Committee they were merely asking that the Government should not leave to chance a result which would probably occur in any case, and that the committee should always include certain elements which, as would be generally allowed, would be indispensable to its efficiency for the purposes which the Bill contemplated.

Need for a Central Authority.

There existed in England a very large supply of institutions which gave secondary education in some form or other. There were public schools, grammar schools, large and small, of various types, proprietary and private schools, technical colleges and institutes, polytechnics, science and art classes in connection with South Kensington; and at the top of the elementary school system there were the higher grade Board schools, some of which were also schools of science, receiving Government aid; there were also higher grade schools not subject to School Boards, but under voluntary management. These various resources for secondary teaching were controlled by various agencies which had no connection with each other. The central control was divided up between the Charity Commission, the Department of Science and Art, and the Education Department; the Board of Agriculture, too, had certain functions in this respect. The local authorities were no less manifold and disparate. Within the same town or district the local power over secondary education might be shared between a county or borough council, a School Board, various governing bodies, committees under the Science and Art Department, and managers of voluntary schools. The inevitable result was overlapping and waste of power, greater or less in different places, but prevalent in some degree everywhere. Such waste of power meant increased cost to the taxpayer or ratepayer. Economy alone dictated organisation. But organisation was also demanded by regard to the efficiency of our secondary system as a whole, which vitally concerned not only our industrial and commercial interests, but also the general welfare of the nation and the empire.

Organisation of Education Board.

The Board of Education Bill introduced in the House of Lords by the Duke of Devonshire last August was to be again introduced this Session. Its object was to establish a Board of Education for England and Wales, which should take the place of the existing Education Department (including the Department of Science and Art at South Kensington), and should also exercise certain powers now pertaining to the Charity Commission. This Board would have the superintendence of all matters relating to education, both secondary and elementary. It might probably be organised in three departments—one for secondary education proper, one for the more technical branches of science and art teaching and for the control of science and art museums, and a third for elementary education. The object was to establish a single strong central authority which could survey the whole field. At the same time, nothing was more remote from the intention of the Bill than to impose a rigid or bureaucratic system of secondary education on the country. There was no idea of a cast-iron uniformity. The local authorities, which in due course would be created, would have free discretion to deal in their own way with the varying needs and circumstances of their respective localities. The central authority would merely exercise a general supervision, affording guidance and assistance as they might be needed. The Duke of Devonshire indicated, in his speech at Birmingham on January 23, what the first task of the new central authority would be. He said that the literary side of education should not be unduly neglected in comparison with the scientific and the technical. It would be a guarantee for the maintenance of the distinctly liberal studies and of that liberal spirit in education generally which was the very breath of life to secondary schools. Already a very large number of schools, of various sizes and types, had had experience of examination by the Universities, and had been thoroughly satisfied with it. About one hundred secondary schools were represented in the Cambridge local examinations, and about the same or a slightly larger number were examined by the Oxford and Cambridge Joint Board. The cost was very moderate, making the aid of the Universities available for many schools of which the resources were comparatively limited. He could not, of course, speak with any authority as to the manner in which the Government might be disposed to regard the suggestion made in this resolution; but it appeared reasonable to hope and believe that the assistance of the Universities in work for which they had already proved their competence, and which had been done to the satisfaction of the schools, would be accepted by the Education Board of the future. Such assistance would so far diminish the number of new inspectors that would have to be appointed. In conclusion, he would only say that the Board of Education Bill appeared to him, on the whole, to receive a cordial welcome from all who were interested in the welfare of secondary education in this country. The Government had shown itself fully alive to the importance of the question. It had chosen the method of procedure which was recommended by practical considerations, and which was most likely to conduce to effective legislation on sound lines and without unavoidable delay. Dr. Jebb concluded by moving the resolutions *en bloc*, and after short addresses by the Master of Trinity, Mr. Swallow, and Mr. Bryce, M.P., the resolutions were put to the meeting and carried.

EXPERIMENTAL CONTRIBUTIONS TO THE THEORY OF HEREDITY.[1]

IN this, the first part of a paper on reversion, the two following questions are dealt with, viz.: (1) Is there invariably evidence of reversion? (2) May reversion, when it does occur, result in the complete, or all but complete restoration of either comparatively recent or of comparatively remote ancestors? The first question is answered in the negative, but to the second an affirmative answer is given. In support of the view that reversion does not invariably occur, it is pointed out (1) that clear evidence of reversion is rare in the pure-bred offspring of highly prepotent animals, such as Galloway, Aberdeen, Angus, and Shorthorn cattle. And (2) that there is sometimes no evidence of reversion in cross-bred animals. While it is deemed unnecessary to submit evidence of the fact, long recognised by breeders, that the offspring of highly prepotent animals are, as a rule, the image of their parents, it is thought desirable to submit evidence in support of the contention that in cross-bred animals indications of reversion may be wholly wanting. The following experiments bear on this point: (*a*) When a prepotent Galloway bull (which is black and hornless) is crossed with a Highland heifer, the result may be an animal which experts are unable to distinguish from a pure-bred Galloway—there may be neither a trace of the long-horned Highland parent, nor yet any indication of reversion. (*b*) A peculiarly marked skewbald (bay and white) Iceland pony mare, when mated with a whole-coloured bay Shetland pony, produced a foal which in colour, form, and gait is almost identical with the skewbald dam—on no single point does it suggest the bay Shetland sire. (*c*) A nearly black Shetland mare, when mated with a bay Welsh pony, produced a bay foal which in its make, colour, &c., is the image of the sire. (*d*) A pure white fantail pigeon, crossed with a blue pouter hen, yielded a nearly white bird having the form and habits of a pouter, but no suggestion of *Columba livia*, the supposed ancestor of the numerous varieties of pigeons. (*e*) A white Shorthorn crossed with Aberdeen, Angus, or Galloway cattle results in "blue-greys," which,

[1] By Prof. J. C. Ewart, F.R.S. (Communicated to the Royal Society of Edinburgh, December 5, 1898.)

though more or less intermediate in their characters, rarely afford any evidence of reversion. It thus appears that, notwithstanding the "swamping effects of intercrossing," the offspring of quite distinct varieties sometimes afford no evidence of reversion, and, further, that Galton's law of heredity (which teaches that the intermediate and remote ancestors together contribute one-half of the total heritage of the average offspring) does not appear to hold in the case of highly prepotent animals. In dealing with the second question, experiments are first described in support of the view that there may be complete, or all but complete, reversion to comparatively recent ancestors. (*a*) A blue and white fantail (a cross between a white fantail and a dark blue cross-bred fantail), when mated with a blue fantail, invariably produces pure white fantails, identical, as far as external characters go, with their grandsire. (*b*) A smooth-coated white rabbit (a cross between an Angora and a smooth-coated white buck), mated with a smooth-coated and almost white doe (the granddaughter of a Himalaya rabbit), produced a litter of three, one of which is the image of the mother, one is an Angora like the grandmother, while the third is a Himalaya (with the characteristic black ears and muzzle and dark grey feet and tail) like the great grandmother.

The following experiment supports the view that there may be reversion to intermediate ancestors:—A Dalmatian dog crossed with a well-bred sable collie produced three pups, which closely resemble young pointers—these pups, with their white ground colour and four or five yellowish-brown patches, in all probability reproduce fairly accurately the intermediate ancestors of the Dalmatian sire. This experiment also suggests that if prepotent ancestors occur along the route which any given variety has travelled, reversion may be at any point abruptly arrested. The remaining experiments detailed afford evidence of more or less complete reversion to comparatively remote ancestors: (*a*) An Indian game Dorking cock, crossed with a dark bantam hen, produced, amongst other birds, a cockerel almost identical with a jungle fowl. It not only resembles *Gallus bankiva* in form and colour, but also in being extremely shy and (unlike the Dorking-like members of the same brood) in its habit of flying away for a considerable distance when suddenly disturbed. (*b*) The zebra-horse hybrids hitherto bred are in their markings very unlike their zebra parent. When the sire or dam is a Burchell zebra, the hybrids in the arrangement of their stripes are not unlike the Somali zebra (*Equus grevyi*), which is, in all probability, in its decoration, the most primitive of all the living zebras. The zebra ♂-horse ♀ hybrids (*Zebrules*), bred by the author at Penycuik, and the horse ♂-zebra ♀ hybrids (*Zebrinnies*), bred at Theobald's Park, Herts, by Lady Meux, differ from the Burchell zebra parents, and agree with the Somali zebra in having (1) rounded instead of pointed arches on the forehead; (2) more than twelve cervical stripes; (3) numerous stripes across the loins and croup—instead of five or six broad oblique stripes—and (4) in having the mane extending some distance beyond the withers.

In one of the Penycuik hybrids there are two sets of stripes over the hind quarters. In this hybrid the more pronounced stripes seem to have been inherited through the zebra parent, while the less distinct, which run in a different direction, have in all probability been inherited through the horse parent. This view is supported by the markings usually found in zebra-ass hybrids, in which the dorsal and shoulder stripes and the bars across the legs are, without doubt, inherited from or through the donkey parent, while the majority of the other markings are probably transmitted by the zebra. (*c*) Mules and hinnies are often more richly striped than their parents; *e.g.* a hinny recently obtained at Penycuik by crossing a light grey she-ass with a bay Welsh pony has, in addition to dorsal and shoulder stripes, distinct bars across the legs—there are no leg bars in either of the parents. Moreover, this hinny is of a yellowish brown colour, and in many ways seems more primitive than either of its parents. (*d*) The nearest approach to complete reversion has hitherto been obtained by crossing pigeons. Darwin, by crossing a barb-fantail with a barb-spot, produced a bird "which was hardly distinguishable from the wild Shetland species."[1]

Referring to this experiment, Weismann says that Darwin devoted his attention to the coloration of the species, and failed to state whether there was complete reversion, *i.e.* a complete agreement in form as well as in colour of the barb-fantail-spot with the wild rock pigeon. By way of settling whether in the case of pigeons complete, or all but complete reversion occurs, the author first crossed an "owl" with an "archangel" pigeon, and then mated the cross-bred bird with a pure white fantail. The owl-archangel cross had neither the frill, short beak, or short round head of the owl, nor yet the crest or bronzed black colour of the archangel. The owl-archangel-fantail cross is almost identical in colour, size, and form with the Indian wild rock pigeon. The only essential difference is in the tail, for though there are twelve feathers (in the fantail parent there are thirty), the tail is slightly arched; this is the only suggestion of the white fantail sire.

The author believes that the experiments recorded afford substantial support to the reversion hypothesis.

[1] "Animals and Plants," vol. i. p. 210.

MASSIVE LAVA FLOWS ON THE SIERRA NEVADA.

AN account of "Some Lava Flows of the Western Slope of the Sierra Nevada, California," is given by Mr. F. Leslie Ransome, in *Bulletin* No. 89 of the United States Geological Survey, 1898. The area is described as having been worn down to a rough peneplain during the interval between the close of the Jura-trias and the beginning of the Miocene period. The rocks upon which this somewhat uneven peneplain has been carved are those of the so-called "Bed-rock series" of the Gold Belt, and are of Jura-trias and earlier age. They consist on the lower slopes (or foothill region) of clay-slates, schists, limestones, quartzites and various igneous rocks; and on the higher slopes mainly of gneissic and granitic rocks.

Volcanic eruptions began during the Miocene period, and, accompanied by elevation and tilting of the peneplain, lasted to the end of the Pliocene. The first eruptions were rhyolitic, followed by the laying down of a great cloak of andesitic breccias and tuffs. The deposition of auriferous gravels both preceded and accompanied the piling up of volcanic materials. Thus the earlier accumulation of andesitic breccias and tuffs was interrupted by at least one period of considerable erosion during which a large stream, the predecessor of the present Stanislaus river, cut through the volcanic cover into the Bed-rock series along the greater part of its course. During subsequent eruptions massive flows of lava extended over limited areas, displacing the stream before mentioned, and following generally the course of the Stanislaus river, while andesitic breccias and tuffs were spread for hundreds of square miles over the western slope of the Sierra. Other more restricted flows of lava followed, and the volcanic period was brought to an end by fresh andesitic eruptions, as shown by breccias which rest on the massive flows of lava. To these lavas the author applies the name of *Latite*, derived from the Italian province of Latium, where there occur in abundance rocks closely related to those he describes. Mineralogically the Sierra Nevada latites are nearly allied to ordinary andesites, but chemically they stand between the andesites and trachytes. They correspond to the plutonic monzonites of Brögger, and represent the effusive forms of the magma. The author would use the term latite in a broad sense, and to include such varieties as toscanite, vulsinite, and ciminite, which have been described by Washington in his studies in the Italian volcanic regions.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—At the 196th meeting of the Junior Scientific Club, on February 3, Mr. F. N. A. Fleischmann exhibited a heart-shaped twin of calcite, and Mr. H. B. Hartley gave an exhibit of Japanese sword blades, explaining at the same time the mode of manufacture that has been used since the fourteenth century in Japan. Mr. M. Burr read a paper on "grasshoppers."—The officers for this term are—President, Mr. F. Soddy (Merton); Chemical Secretary, Mr. H. B. Hartley (Balliol); Biological Secretary, Mr. A. G. Gibson (Ch. Ch.); Treasurer, Mr. W. E. Blackall (Non-Collegiate); Editor, Mr. H. E. Stapleton (St. John's); Committee, Mr. F. N. A. Fleischmann (Magdalen), Mr. E. Gurney (New College), and Hon. F. R. Henley (Balliol). At the next meeting of the Club (Wednesday, February 15), Prof. Odling, F.R.S., will read a paper on "Chemical

Theories under discussion about the year 1850—some personal reminiscences."

Cambridge.—The General Board of Studies has received offers from Sir Walter Gilbey, the Board of Agriculture, certain County Councils, and the Drapers' Company of sums amounting to over 2000*l.* a year for the next ten years for the support of a department of Agricultural Science in connection with the University. The Board proposes that a Professorship of Agriculture should be founded, together with a Board of Agricultural Studies to whom the administration of the department will be entrusted; and recommend that the offers be gratefully accepted by the University. Detailed proposals for the organisation of the department will be hereafter submitted, provided the general scheme is approved by the Senate. It is estimated that, during the ten years for which in the first instance the department will be established, its operations can be carried on without entailing any financial responsibility on the University Chest.

Mr. B. L. Cohen, M.P., has promised 3000*l.* to the University Benefaction Fund, and a number of smaller donations have been received as a result of the formation of the Cambridge University Association.

Captain Partington has given 2000*l.* towards the cost of building the new physical laboratory of Owens College, Manchester.

Prof. Cleveland Abbe is reported by *Science* to have given to the Johns Hopkins University his valuable collection of books, journals and pamphlets relating to meteorology.

The views of several American naturalists on advances in methods of teaching were discussed at the recent meeting of American Naturalists and Affiliated Societies, and are printed in *Science* of January 20. The subjects dealt with are: zoology, by Prof. E. G. Conklin; anatomy, Prof. G. S. Huntington; physiology, Prof. W. T. Porter; psychology, Prof. H. Munsterberg; anthropology, Dr. Franz Boas; botany, Prof. W. F. Ganong.

A copy of the Tōkyō Imperial University Calendar for the year 1897–98 has been received. At the end of the Calendar is a long list of papers published since 1887 in the Journals of the Medical and Science Colleges, the Memoirs of the Literature College, and the Bulletins of the Agriculture College. Since the Calendar went to press, the president of the University, Prof. Masakazu Toyama, has been appointed Minister of State for Education, and has been succeeded by Prof. Dairoku Kikuchi, M.A. (Cantab.).

The patronage of the chair of Pathology now vacant in the University of Glasgow is in the hands of a Board of Curators, four of whom are appointed by the University Court, and three by the Managers of the Western Infirmary. The Curators met on Thursday, February 2; there were present:—The Principal (in the chair), Dr. Hector Cameron, Dr. McVail, Mr. J. H. Dickson, Mr James Boyd and Mr. William Ker. Instructions were given to advertise the vacancy—applications to be sent in by March 24. The new professor will be required to begin his duties on April 25.

A graduates' magazine, *The Technology Review*, has just been issued by the recently organised Association of Class Secretaries of the Massachusetts Institute of Technology. It is an octavo volume of 140 pages, attractive in appearance, and well produced. The first number contains the introduction; a photograph with biographical sketch of President Crafts; articles on "The Function of the Laboratory," by Prof. Silas W. Holman; and on the "Pierce Building," by Prof. Eleazer B. Homer, the architect; reprints in fac-simile of early institute documents and letters—all in the first and more general half. The latter half, seventy pages, is given to news of the Institute, of the undergraduate and graduate classes. Plans are shown of the several floors of the new Pierce Building, of the first floor of the Rogers Building as now altered, and of the dynamo house. A good review of Prof. Holman's recent book on "Matter, Energy, Force and Work," is given by Dr. Goodwin.

The seventh annual report of the Technical Instruction Committee of the City of Liverpool shows that the work of the Committee during the past year has been for the most part concerned with the consolidation and improvement of work previously in existence. There is reason to hope that, even before legislation takes place, means will be devised for the establishment of a satisfactory working scheme of co-ordination of all the public educational agencies of the City. The establishment of a School of Commerce—at present on a comparatively small scale it is true—by co-operation with the Liverpool Chamber of Commerce and the authorities of University College, constitutes an important development of higher commercial instruction, which, in another form, was comprised in the original scheme of the Committee. The school was started at the beginning of the winter session with very good promise of success.

The proportion of children who should be receiving a secondary education has been variously estimated by different authorities. The Schools Inquiry Commissioners in 1868 estimated the proportion at 12·8 per thousand for boys, but made no estimate for girls. Committees working under the Welsh Intermediate Act have taken 20 per thousand (viz. 12 boys and 8 girls) as their estimate of the proportion of the population for whom provision should be made. The recent annual report of the Liverpool Technical Instruction Committee mentions that the number of Liverpool pupils attending secondary schools is approximately 7·5 per thousand of the population. The Committee point to this figure as an eloquent testimony to the deficiency which exists in Liverpool in the present provision for secondary education, and the urgent necessity for the matter to be dealt with, in the interests both of the City and of the nation, by some responsible public authority.

The *Record of Technical and Secondary Education* refers to the constitution of the new University of London as "an event which will greatly affect the higher technical teaching of the metropolis. The Technical Education Board are giving considerable attention to the subject, and have formed a special sub-committee to report upon the matter and to frame a memorial to the Commissioners. It seems probable that the new University will give a stimulus to the development of economic and commercial teaching, and measures are likely to be taken for strengthening those subjects in the various schools and institutions of London. Commercial education has, during the past year, been under the consideration of a special committee of the London Chamber of Commerce, and also a special sub-committee of the Technical Education Board. The last-named committee have collected a considerable amount of evidence, and are likely to issue their report in the course of a few weeks."

Mr. S. Prout Newcombe has offered the London County Council his educational collection of natural history specimens and literature. This collection, which consists of about 21,000 objects, with a considerable number of works on natural history subjects, all classified to correspond with the examples, is at present accommodated in the Free Library of St. George's, Hanover Square. The Library Commissioners accepted the collection in May 1894, subject to the provision that they might return it at the end of four years if they were no longer able to afford it accommodation. The requirements of the library now demand additional space, and it has been found that to make the collection as useful as possible a lecture-class-room should be associated with it. The Commissioners have, therefore, availed themselves of the provision in the deed of gift, and have asked Mr. Prout Newcombe to remove the collection. The General Purposes Committee of the London County Council, who have had the offer under consideration, now recommend the Council to accept the gift.

The will of the late Mr. Edward Austin, of Boston, Massachusetts, provides for public bequests of more than one million dollars, four hundred thousand dollars going to the Massachusetts Institute of Technology. *The Technology Review* gives the following extracts from the will referring to gifts to educational institutions. I give to Harvard College, Cambridge, 500,000 dollars, the interest upon which they will pay to needy meritorious students and teachers, to assist them in payment of their studies. To the Massachusetts Institute of Technology, I give four hundred thousand dollars, the interest to be applied as that of my bequest to Harvard College. To Radcliffe College (women's college) I give thirty thousand dollars, the interest to be in the same as that to Harvard College. To Roanoke College (Julius D. Dreher, president) I give thirty thousand dollars, on same terms as that to Harvard

College. To Tuskegee Normal and Industrial School (Booker T. Washington), I give thirty thousand dollars, on same terms as that to Harvard College. I give to bacteriological laboratory (Harvard Medical School) ten thousand dollars. Mr. Austin was one of the class of East India merchants so prosperous in the first half of this century. He was born in Portsmouth in 1803, but his childhood was spent in Boston, where also his permanent home and interests were centred.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xxi. No. 1, January.—Systems of revolution and their relation to conical systems in the theory of Lamé's products, by F. H. Safford. In problems requiring the solution of Laplace's equation, it is often possible (the author remarks) to obtain a solution by transferring to curvilinear coordinates, λ, μ, ν, and assuming that V is a product of three factors, *i.e.* $V = L.M.N$, where L, M, N are functions of λ, μ, ν respectively. Such an expression for V is called a Lamé's product. The problem treated is an application of a theorem due to Lord Kelvin, by means of which, from a known solution, V, of Laplace's equation in terms of coordinates corresponding to a system of mutually orthogonal surfaces, a solution may be readily deduced for a new system of surfaces obtained from the first by inversion. The theorem is used in an extended sense, so that real surfaces have been obtained from imaginary surfaces by inversions with regard to imaginary points as centres. A. Wangerin, in his "Reduction der Potential-Gleichung" (Leipzig, 1875), has discussed many of the topics considered here with the aid of elliptic functions. The use of these functions is avoided in the present paper. Wangerin states that the most general surfaces of revolution for which Lamé's products, with an extranenus factor, exist, are those whose meridian curves are obtained from the curves (got by equating the real and imaginary parts of the equation $x + ri = f(t + m)$, where f is either sn or cn) by an inversion with respect to a point on the axis of revolution. The same topics are treated by Haentzschel in his "Reduction der Potential-Gleichung" (Berlin, 1863), but he obtains surfaces of revolution of the thirty-second degree.—A. L. Baker contributes a short elementary proof of Cauchy's theorem, $W = \int dW = \int wdz$, taken around a closed curve enclosing no point where $w = \infty$ is zero.—The number is closed with a long essay (pp. 25–84), by C. L. Bouton, entitled "Invariants of the general linear differential equation and their relation to the theory of continuous groups." The titles of the chapters will indicate the line of work. Cap 1. Cockle's work ("Criticoids") and differential covariants. Cap 2. Cockle's results by Lie's methods. Cap 3. Invariants of the general linear differential equation in two variables for transformation of both variables. Cap 4. Consideration of a subgroup. Cap 5. Differential equation in canonical form (complete solution in explicit form of the problem of finding all the covariants and invariants of the equation in its canonical form (Forsyth's "Identical Covariants," &c.). The bibliographical references and the consideration of Sir J. Cockle's scattered results (the first dating from 1862) are a very useful feature of the memoir.—The pictorial accompaniment of the initial number of the new volume is a photograph, from a painting, of Prof. Simon Newcomb.

Wiedemann's Annalen der Physik und Chemie (Supplementary Number, 1898).—Mobilities of electric ions, by F. Kohlrausch. The conductivities of very dilute solutions may be theoretically determined from their concentrations by adding up the separate mobilities of the ions constituting the molecule. The author gives tables of mobilities from which the conductivities of monovalent salt solutions can be calculated down to concentrations of decinormal strength.—Kinetic theory of liquids, by C. Dieterici. It is shown that by applying the methods and data of the kinetic theory of gases, the properties of liquids may be to a large extent mathematically deduced. The size of the molecules exerts of course a great effect, and it will have to be more definitely known before the liquid theory is complete.—Magnetisation by alternating currents, by Max Wien. Toroids of soft iron wire, exposed to alternations of 128, 256, or 512 per second, provided by an alternate current siren, are not capable of following those frequencies by corresponding magnetic inductions. Eddy currents of higher periods are developed, and the soft iron becomes magnetically harder.—Reaction pressure of kathode rays, by E. Riecke. An ordinary radiometer is used to determine the reaction pressure, the vanes acting as kathodes. The pressure is proportional to the current intensity, with a current of 3×10^{-6} absolute units the pressure is 0·04 dynes per square cm.—Induction coils, by W. Hess. The discharge of an induction coil is studied by introducing a liquid condenser in parallel with the spark gap. The liquid condenser contains CS_2, and produces a Kerr effect between two crossed nicols. A strained glass plate is put between the nicols, and converts the dark field into a field of fringes. These are displaced by any fluctuation of potential, and when the displacements of a section of the fringes are photographed, a record is obtained of the whole course of the discharge Some excellent photographs are reproduced.—Effect of Rontgen rays upon spark discharges, by H. Starke. Like ultra-violet light, Röntgen rays are capable of reducing the discharge potential between terminals upon which they impinge. But, unlike ultra-violet rays, they are indifferent as to the sign of the terminal impinged upon.—A new method of demonstrating Hertz's experiments, by J. Precht. The sections of a Hertzian resonator provided with a parabolic mirror are connected with a spark gap having a blunt kathode and a pointed anode. A steady discharge from an influence machine traverses the spark gap, and the gap is so adjusted that only a glow discharge passes. Any electromagnetic waves received by the mirror convert the glow into a shower of sparks, and at the same time the discharge potential is diminished.—Use of the coherer, by O. Behrendsen. For showing the reflection of electromagnetic waves, it is necessary to use a coherer which is not very sensitive, and to avoid single wires. The author uses a coherer made of powdered arc carbon.—Pyro-electricity and piezo-electricity, by W. Voigt. The question is raised whether the whole of the pyro-electric charge of a crystal can be described as piezo-electric, and as due to the change of volume which accompanies every change of temperature. The author shows that in tourmaline and other crystals with a singular axis, about 20 per cent. of the charge is purely pyro-electric. In the other crystals it is altogether piezo electric.—Gliding discharge along pure glass surfaces, by M. Toepler. The length of sparks in air may be considerably extended by making them pass along glass surfaces backed by tinfoil, which is in metallic connection with one of the terminals.—Magnetisation of crystals in different directions as depending upon temperature, by Ascan Lutteroth. Faraday found that the orientation of a crystal in a magnetic field is less pronounced at higher than at lower temperatures. The author shows by experiments on various sulphates that this may or may not be true according to the choice of the axis of suspension, and explains his observations on the basis of molecular magnets.—Conduction of electricity by thin sheets of dielectrics, by W. Leick. Gutta-percha, paraffin, and sulphur show greater conductivity in thin layers than in thick layers. The conductivity depends upon the current strength, the resistance decreasing as the current increases. Gutta-percha and paraffin do not show any polarisation, but sulphur does.—Absorption of uranyl salts, by Ernst Deussen. Kundt's law of dispersion does not apply to the more easily soluble uranyl salts such as the nitrate and the chloride. But it holds for the nitrate in glycerin, and for the chloride in alcohol. In the case of the less soluble salts, such as the sulphate, acetate, and oxalate, the bands are displaced towards the red.—Effect of gases and metals upon the photographic plate, by B. von Lengyel. Hydrogen is capable of modifying silver bromide so as to give images on development. Metals which, like zinc, are capable of disengaging hydrogen from moist air, also exert an effect upon the sensitive plate. The Becquerel rays of uranium and thorium are, however, a pure radiation.—Visibility of Röntgen rays, by E. Dorn. The X-rays are not only visible to the ordinary eye, but to totally colour-blind eyes, sometimes appearing exceedingly bright, but always diffused owing to the absence of refraction. The rods of the retina are more affected by them than the cones.—A new electromagnetic string interrupter, by L. Arons. This interrupter dispenses with electromagnets, the vibrating string being attracted by a permanent magnet, which breaks the circuit by withdrawing a platinum wire attached to the string from a mercury surface. The attraction is electrodynamic. Since the self-induction of the circuit can be thus made very small, very high frequencies can be attained.

SOCIETIES AND ACADEMIES

LONDON.

Royal Society, January 19.—"On the Vibrations in the Field round a Theoretical Hertzian Oscillator." By Karl Pearson, F.R.S., and Alice Lee, B.A.

The object of this paper is to investigate the types of wave motion in the neighbourhood of a *theoretical* Hertzian oscillator. By a theoretical Hertzian oscillator the writers understand a Maxwellian "double point" of initial maximum moment $\pm El$. But as the actual oscillator has been shown by Bjerknes and others to give a damped wave train, they take the maximum moment to run down with the time, and to oscillate between the limits $\pm El\epsilon^{-p_1t}$. This gives a wave train corresponding to that observed by Bjerknes and represented at a given distance by

$$C\epsilon^{-p_1t}\sin(p_2t+\gamma).$$

The investigation for a "double point" with a *steady* wave train was originally made by Hertz himself, and has found its way into most of the current text-books of electro-magnetism. The theory there given, is insufficient for two reasons, both of which were recognised by Hertz himself, namely, because (i.) the actual oscillator has sensible extension, and (ii.) the wave train it gives forth is not steady.

The present paper only attempts to remove the latter objection to Hertz's original theory: like that theory it becomes less accurate as we approach nearer to an actual oscillator. The chief divergences between the present and Hertz's original theory actually fall in that portion of the field wherein his chief interference experiments were made.

The writers investigate the general theory of a double point with damped intensity, and replace the well-known Hertzian diagrams of the field by a more complete series of 56, representing the field for seven complete oscillations, and showing how the field for some twelve metres round the oscillator chosen, gradually falls to nearly $\frac{1}{60}$ of its maximum initial strength. These diagrams are entirely due to Miss Alice Lee, and involved a large expenditure of labour and time, which would, perhaps, not have been justified were any other graphic representation of a damped wave motion available.

The writers next deal with the type of waves propagated, their velocities and their phases. The following general conclusions are reached:

(i.) Three waves of electro-magnetic force may be considered as sent out from the oscillator. These are:—

(*a*) A wave of purely transverse electric force.

(*b*) A wave of electric force parallel to the axis, briefly termed the wave of axial electric force.

(*c*) A wave of magnetic force.

The waves of axial electric and of magnetic force move outwards with the same velocity, which is, however, a function of the distance from the centre of the oscillator. The intensity of both forces for points on the same sphere varies as the cosine of the latitude, the polar axis being the axis of the oscillator.

The wave of transverse electric force is propagated with the same velocity at all equal distances from the centre of the oscillator, but this velocity differs from that of the two previous waves; further, the amplitude is independent of the latitude, being constant over any sphere. The velocity after the wave has reached a certain distance from the double point is always greater than that of the waves of magnetic and of axial electric force. Its excess over the velocity of light tends to become three times the excess of the velocity of the magnetic wave over the velocity of light; both the excesses decreasing asymptotically.

(ii.) The velocities of these waves undergo remarkable changes in the neighbourhood of the oscillator, but these changes extend to distances which are greater than those within which a great proportion of Hertz's interference experiments were made.

(iii.) The point of zero phase for both transverse and axial electric waves does not coincide with the centre of the oscillator, so that these waves appear to start from spheres of small but finite radius round the oscillator. A fourth wave dealt with by Hertz, namely, the wave of magnetic induction, does not, as he supposes, start with zero phase from the origin, but with a finite phase. The wave in the equatorial plane, largely relied upon by Hertz for his interference experiments "of the first kind," is a compound of the waves of transverse and axial electric force, and has a much more complex series of velocity changes than Hertz appears to have realised.

(iv.) The existence of the two electric force waves and the singular changes of the wave motion in the neighbourhood of the oscillator very possibly throw light on the difficulties which arise in Hertz's experiments. It would seem that such experiments should be made at distances greater than 6 to 7 $(\lambda/2\pi)$ from the centre of the oscillator, or, roughly, about a wavelength from the oscillator. In Hertz's case this amounts to about 10 metres—a distance at which Hertz rather terminated than started his interference experiments.

February 2.—"Sets of Operations in Relation to Groups of Finite Order." By A. N. Whitehead, M.A. Communicated by Prof. A. R. Forsyth, F.R.S.

The present paper is concerned with the Theory of Groups of Finite Orders. The more general object of the paper is to place this theory in relation to a special algebra of the type considered in the general theory of Universal Algebra. This special algebra, which may be called the Algebra of Groups of Finite Order, has many affinities to the Algebra of Symbolic Logic; and a comparison of it with this algebra is given in the last section of this paper.

The N symbols, or operations, are considered to be capable of addition according to the law

$$S+S=S.$$

This is the well-known law of addition in Symbolic Logic, and the introduction of numerical symbols as factors is thereby avoided.

The sum of a selection of the N fundamental operations, such as $S_p+S_q+S_r+S_t$, is called a set. If a set obeys certain special conditions it is called a group. The sum of the whole number (N) of fundamental operations, namely, $S_0+S_1+\ldots\ldots+S_{N-1}$, obeys these conditions. This sum is called the complete group, and all other groups are its sub-groups.

The first six sections of this paper are devoted to the detailed establishment of this purely algebraic view of the subject. At times the modification in treatment from that adopted in the standard treatises on the subject, such as Burnside's "Theory of Groups of Finite Orders," is slight.

The more special object of this paper follows directly from the changed point of view from which the Theory of Groups is here regarded. The idea of the group is no longer so absorbing; the set takes its place as the fundamental general entity which has to be investigated. Accordingly in this paper some of the general properties of sets are investigated. A set of operations has numerous groups associated with it, and these groups have many relations with each other. The fundamental idea of this part of the paper (*cf.* § 7) is the formation from a set H of an unending series of other sets, here called the successive powers of H, and in the notation of the algebra written H^2, H^3,...... This series is called the power sequence of H. Any group which contains H also contains its power sequence. The power sequence is proved to have a periodic property (*cf.* § 9) which introduces a curious analogy to recurring decimals. This periodicity is the foundation of the rest of the paper. It governs the relations to each other of the various allied groups and sets. The periodicity is expressed by an equation of the form

$$H^{n+sm+q}=H^{n+q},$$

where m is called the period of H, and n the characteristic, and s and q are any integers including zero. The number of theorems relating to m is very large.

Linnean Society, January 19.—William Carruthers, F.R.S., Vice-President, in the chair.—Mr. H. W. Monckton exhibited specimens of *Mya arenaria*, Linn., from Norway. He and Mr. R. S. Herries (Sec. Geol. Soc.) had found a colony of these molluscs living on a sand-flat at the head of the Fjærland Fjord, about eighty miles from the open sea and where the water at the surface is fairly fresh. The great snowfield, the Sostedal, approaches close to the north-west side of the fjord, and at a level of only 3500 feet to 4000 feet above it, where glaciers descend into the valleys at the head of the fjord to within four miles of the mud-flat in question. The shells were for the most part small and thin, and this might be due to the freshness or to the coldness of the water, or both.—Dr. W. G. Ridewood read a paper, entitled "Some Observations on the Caudal Diplospondyly of Sharks," from which he concluded that the occurrence of twice as many vertebræ as muscle-segments is a secondary feature, but one of ancient date; and,

further, that it is purely adaptive, being calculated to maintain a due proportion between the length of the centrum and the width of the body, without diminishing the length of the muscle-segments.—Mr. George Murray, F.R.S., and Miss F. G. Whitting (Newnham Coll., Camb.) communicated a paper on new Peridiniaceæ from the Atlantic, of which (in the absence of Mr. Murray through indisposition) an abstract was given by the Secretary.—Mr. A. J. Maslen read a paper on *Lepidostrobus*. After remarking that the late Prof. Williamson's collection of fossil plants in the Natural History Museum contained a number of slides which he had associated with *Lepidostrobus*, but which could not be referred with certainty to the particular vegetative organs to which they belonged, while it was difficult also to refer isolated sections of the same type of *Strobilus* to one another, he explained that the present paper gave the result of a re-examination of Williamson's slides of *Lepidostrobus*, undertaken at the suggestion of Dr. D. H. Scott. His object and endeavour had been to make out, if possible, at least some distinct forms; but he had found great difficulty in determining whether the observed structural differences in isolated sections were really of specific value or not. He considered it safer to adopt Williamson's *Lepidostrobus Oldhami* for a common type of structure, and by comparison to describe three marked variations (α, β, and γ). A clearly distinct form he described as a new species under the name *Lepidostrobus foliaceus*.

Entomological Society, January 18.—Annual Meeting.—Mr. Roland Trimen, F.R.S., President, in the chair.—It was announced that the following gentlemen were elected as officers and Council for 1899:—President, Mr. G. H. Verrall; Treasurer, Mr. R. McLachlan, F.R.S.; Secretaries, Mr. J. J. Walker and Mr. C. J. Gahan; Librarian, Mr. G. C. Champion; and as other members of Council, Mr. W. F. H. Blandford, Dr. T. A. Chapman, Mr. H. St. J. K. Donisthorpe, the Rev. Canon W. W. Fowler, Mr. A. H. Jones, Mr. F. Merrifield, Mr. E. Saunders, Mr. R. Trimen, F.R.S., Mr. J. W. Tutt and Mr. C. O. Waterhouse.—The address of the retiring President was then read by the Secretary. In this, after a review of the present position of the Society, an account was given of the various experimental researches and observations made on the subject of seasonal dimorphism in lepidoptera from those of Weismann down to the evidence recently brought forward by Dr. Dixey on the existence of this phenomenon in Neotropical Pierinæ.

MANCHESTER.

Literary and Philosophical Society, January 24.—Mr. J. Cosmo Melvill, President, in the chair.—The President announced that the Council had awarded the Wilde Medal of the Society for 1899 to Sir Edward Frankland, K.C.B., F.R.S., and the Wilde Premium of fifteen guineas to Dr. Charles H. Lees. The presentation of the medal and premium had been fixed for February 28, when the Wilde Lecture would also be delivered by Prof. William Ramsay, F.R.S.—Dr. F. H. Bowman stated that he had recently seen a specimen of wheat grown in South Africa, consisting of about 420 stalks which were apparently produced from a single seed; each stalk had an ear containing on the average forty grains. The President and Mr. Charles Bailey agreed that the plant was most probably *Triticum compositum*, and Mr. Tristram stated that plants bearing 190 stalks had been grown in Lancashire.—The President exhibited specimens of *Eichhornia speciosa*, Kunth (the water hyacinth), and *Blitum virgatum*, L. (the strawberry blite), and also a series of leaves of the common holly (*Ilex aquifolium*, L.) showing every kind of variation.—Mr. Charles Bailey explained the structure of the peculiar permanent sheath which encloses the extremity of each root and rootlet of the *Pontederia* (*Eichhornia*) *crassipes*. The specimens exhibited to the members under the microscope showed that these sheaths were like the long finger of a glove in shape, and varied in size according to the age of the organ. The organic connection between the root and its sheath is found at the extremity of the root at the bottom of the sheath. The sheaths are of fair consistency, and are doubtless designed for the protection of the plant, which, by means of its inflated leaf-stalk, passes its life floating upon the surface of the water; the growing and tender extremities of the root are in this way guarded against the attacks of the smaller aquatic animals. The species of the cryptogamic genus *Azolla*, which also pass their existence in a floating condition, have a very similar root-sheath, but in their case the organ is only temporary, being discarded before the root reaches maturity.

PARIS.

Academy of Sciences, January 30.—M. van Tieghem in the chair.—Remarks by M. Faye on vol. i. of the *Annales de l'observatoire de Nice*.—Observation of the B-group in the solar spectrum, made at the summit of Mont Blanc, by M. A. de la Baume-Pluvinel. Photographs of the solar spectrum at Paris, Chamonix, and the summit of Mont Blanc, show that the group of B lines still remains at the highest elevation, but with an intensity much less than in the lower layers of the atmosphere.—Remarks on the preceding communication, by M. Janssen.—On the generalisation of the first method of Jacobi, by M. N. Saltykow.—On groups of the class $N - u$ and of degree N, transitive not less than $u - 1$ times, by M. Edmond Maillet.—On the problem of iteration, by M. Lémeray.—On the prolongation of analytical functions, by M. Émile Borel.—On orthogonal systems, by M. A. Pellet.—Doubly cylindrial surfaces and isothermal surfaces, by M. L. Raffy.—On surfaces of total constant curvature, by M. Tzitzéica.—On the lines of curvature of certain surfaces, by M. Blutel.—On curves of traction, by M. H. Bouasse.—Permanent torsion and the point of recalescence in steel, by M. G. Moreau. It is shown that for wires of different diameters with a sufficiently large initial torsion, the relation between the residual torsion T_r, the torsion T, and the diameter d, is given by $T_r = T - k/d$. Measurements of k for a well tempered steel wire raised to different temperatures by means of an electric current, showed that k remained constant up to about 300°, and then slowly diminished up to the point of recalescence, 715°, after which it remained constant.—Double refraction produced by the magnetic field related to the Zeeman phenomenon, by M. A. Cotton. In a previous paper it has been shown that the production of a magnetic field affects the optical properties of sodium vapour and nitrogen peroxide. An analysis of the light which reappears under the action of the field now shows that the explanation originally suggested is correct; for each of the new rays created by the field, the flame absorbs from the ray of white light only those vibrations identical with those it emits itself.—On the transparency of opaque bodies for luminous radiations of great wave-length, by M. Gustave de Bon. With a lamp wrapped in black paper, objects placed in an opaque box in contact with a phosphorescent zinc sulphide screen could be photographed.—On the differences existing between X-rays proceeding from one body, by M. G. Sagnac. The bundle of secondary rays emitted by a heavy metal exposed to X-rays, consists of rays of very different penetrative power, in every case less than that of the original rays.—The explosive power of acetylene at very low temperatures, by M. Georges Claude. The solubility of acetylene in acetone increases very rapidly as the temperature diminishes, acetone at −80° dissolving more than 2000 volumes of the gas. A platinum wire may be kept at a red heat in this solution without any explosion taking place. Liquid acetylene at −80° behaves similarly.—On the alloys of iron and nickel, by M. F. Osmond. A series of iron-nickel alloys was prepared, containing only small amounts of manganese and carbon, and in which the nickel varied in amount from 0·27 to 98·5 per cent. These alloys were heated, and the temperature at which their magnetic properties vanished noted: the curve showing the results has three branches, showing maximum transformation temperatures at 0, and 70 per cent. of nickel.—On the decomposition of carbon monoxide in presence of metallic oxides, by M. G. Boudouard. Carbon monoxide was passed over the oxides of nickel, cobalt, and iron, at 445°, and the rate of reduction measured. If the time of heating is sufficiently prolonged the decomposition is total with the oxides of nickel and cobalt.—On a new method of estimating carbon monoxide, by MM. Schlagdenhauffen and Pagel. Carbon monoxide completely reduces silver oxide at 60°, cuprous oxide at 215°–300°, and hence these oxides may be used to estimate the gas.—On some aromatic iodo-ketones, by M. A. Collet. A description of the preparation and properties of iodo-acetophenone, $C_6H_5.CO.CH_2I$, and the corresponding $CH_3.C_6H_4.CO.CH_2I$, and $CH_3.C_6H_4.CO.CHI.CH_3$.—Remarks on the preparation of the oxyethylamines, by M. F. Chancel. By the action of ammonia upon glycol chlorhydrin, the chlorhydrate of trioxyethylamine is readily obtained in a pure state.—Extraction and synthesis of the perfume of the jasmine flower, by M. Albert Verley. Preliminary attempts to isolate the essence by distillation with steam having failed, the perfume was taken up by fat in the usual way. This extracted with heavy petroleum oil and acetone gave only 40 gr., 90 per cent. of which

was submitted to distillation under reduced pressure. A liquid was isolated of the composition $C_9H_{10}O_2$, which proved to be the methyl acetal of phenyl-glycol. It was synthesised by heating phenyl-glycol and formaldehyde with dilute sulphuric acid on the water bath.—Action of the benzidine diazochlorides of orthotoluidine and orthodianisidine upon acetylacetone, by M. G. Favrel.—On the reducing power of the tissues, by M. Henri Hélier. The reducing power of a tissue is defined as the quantity of oxygen that a gram of it is capable of removing from potassium permanganate to reduce the latter to Mn_2O_3. The present paper gives data for the liver and pancreas.—The clinical exploration of the renal functions and of phloridzic glycosuria, by M. Ch. Achard.—Action of the Turkish bath upon the internal organs, by MM. Bianchi and Félix Regnault. —On a hailstorm observed at Bizerte, by M. Voiellaud.—Barometric movements on the orthogonal of the meridian of the moon, by M. A. Poincaré.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 9.

ROYAL SOCIETY, at 4.30.—On the Reflection of Cathode Rays: A. A. C. Swinton.—On the Recovery of Iron from Overstrain: James Muir.—A Soil Bacillus of the Type of De Bary's *B. megatherium*: Dr. W. C. Sturgis.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

MATHEMATICAL SOCIETY, at 8.—On a certain Minimal Surface and on a Solution of $\nabla^2 V = 0$: T. J. Bromwich.—The Group of Linear Homogeneous Substitutions on mq Variables which is defined by a certain Invariant: Dr. L. E. Dickson.—On the Complete System of Differential Covariants of a Single Pfaffian Expression, and of a Set of Pfaffian Expressions: J. Brill.—Groups of Order p^3q: E. A. Western.—The Irreducible Concomitants of any Number of Binary Quartics: A. Young.—The Scattering of Electric Waves by an Insulating Sphere; A. E. H. Love, F.R.S.—The Figure of Jacobi with respect to a Linear System of Hyperquadrics: Prof. Schoute.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains: J. Pigg.—The Regulation of Wiring Rules: C. H. Wordingham.—The Institution Wiring Rules: R. E. Crompton.—(Continuation of Discussion, if time permits): Electric Traction by Surface Contacts: Miles Walker.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Fifth Report to the Alloys Research Committee: Steel: Sir William C. Roberts-Austen, K.C.B., F.R.S.—Machinery for Book and General Printing: William Powrie.—Evaporative Condensers: Harry G. V. Oldham.

CAMERA CLUB, at 8.15.—The Heat of the Moon: The Earl of Rosse, F.R.S.

FRIDAY, FEBRUARY 10.

ROYAL INSTITUTION, at 9.—Motion of a Perfect Fluid: Prof. H. S. Hele-Shaw.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Anniversary Meeting.

PHYSICAL SOCIETY, at 5.—Annual General Meeting.—Address by the President.—An Ampere-Meter and a Volt-Meter with a Long Scale: Benjamin Davies. (This will probably be read by Dr. Lodge.)

MALACOLOGICAL SOCIETY, at 8.—Annual General Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Electrical Driving of Engineering Workshops: William Middleton.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.

SATURDAY, FEBRUARY 11.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh.

MONDAY, FEBRUARY 13.

IMPERIAL INSTITUTE, at 8.30.—Cuba: Richard Davey.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploration in the Canadian Rockies: a Search for Mount Hooker and Mount Brown: Prof. Norman Collie, F.R.S.

TUESDAY, FEBRUARY 14.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Lake Superior Iron Ore Mines, and their Influence upon the Production of Iron and Steel: Jeremiah Head and Archibald P. Head.

ANTHROPOLOGICAL INSTITUTE, at 8.—The Arabs of the Indian Frontier: Sir T. H. Holdich, R.E., K.C.I.E., C.B. (With Lantern Illustrations.) —Exhibition of Photographs by J. Guthrie Watson.

ROYAL HORTICULTURAL SOCIETY.—Annual Meeting.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Annual General Meeting.

WEDNESDAY, FEBRUARY 15.

SOCIETY OF ARTS, at 8.—The Balloon as an Instrument of Scientific Research: Rev. John M. Bacon.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Report on the Phenological Observations for 1898: Edward Mawley.—The Circulation of the Atmosphere: Prof. W. M. Davis.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Preceded at 7.30 by an Exhibition of Objects shown by Multiple-Colour Illumination: Julius Rheinberg.

ENTOMOLOGICAL SOCIETY, at 8.

OXFORD UNIVERSITY SCIENTIFIC CLUB, at 3.—Chemical Theories under Discussion about the Year 1850—some Personal Reminiscences.

THURSDAY, FEBRUARY 16.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On the Reflex Electrical Effects in Mixed Nerve and in the Anterior and Posterior Roots: Miss Sowton. The Characteristic of Nerve: Dr. A. D. Waller, F.R.S.—Observations on the Cerebro-spinal Fluid in the Human Subject: Dr. St. Clair Thomson, Dr. L. Hill, and Prof. Halliburton, F.R.S.—The Thermal Deformation of the Crystallised-Normal Sulphates of Potassium, Rubidium, and Cæsium: A. E. Tutton.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

LINNEAN SOCIETY, at 8.—On the Genus *Lemnalia*, Gray, with an Account of the Branching Systems of the Order Alcyonacea: Gilbert C. Bourne.—On some African *Labiatae*, with Alternate Leaves: J. H. Burkill and C. H. Wright.—Report on the Marine Mollusca obtained during the First Expedition of Prof. A. C. Haddon to the Torres Straits: James Cosmo Melvill and Robert Standen.

CHEMICAL SOCIETY, at 8.—On the Absorption Spectrum and Constitution attributed to Cyanuric Acid: W. N. Hartley, F.R.S.—Ballot for the Election of Fellows.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Recherches sur les Instruments les Méthodes et le Dessin Topographiques; Colonel A. Laussedat (Paris, Gauthier-Villars).—Elementary Hydrostatics: C. Morgan (Rivingtons).—Die Welt als That: Dr. I. Reinke (Berlin, Paetel).—West African Studies: M. H. Kingsley (Macmillan).—Vaccination; its Natural History and Pathology; Dr. S. M. Copeman (Macmillan).—Society for the Promotion of Engineering Education. Proceedings of the Sixth Annual Meeting (Columbia, Mo.).—Elementary Physiology: B. Moore (Longmans).—An Introduction to the Differential and Integral Calculus and Differential Equations: F. G. Taylor (Longmans).—Instinct and Reason: H. R. Marshall (Macmillan). —The Human Body: Prof. H. N. Martin, 5th edition (New York, Holt). —A Junior Course of Practical Zoology: A. M. Marshall and C. H. Hurst, 5th edition (Smith, Elder).

PAMPHLETS.—Licht-, Elektrizitäts- und X-Strahlen: R. Mewes, Zweite Ausgabe (Berlin, Krayn).—Sprachregeln für die Bildung und Betonung Zoologischer und Botanischer Namen: P. Kretschmer (Berlin, Friedländer).—Dietary Studies in Chicago (Washington).

SERIALS.—Contemporary Review, February (Isbister).—Photogram, February (Dawbarn).—Physical Society of London, Proceedings, January (Taylor).—Transactions of the Natural History Society of Glasgow, Vol. v., n. s., Part 2 (Glasgow).—Natural Science, February (Pentland).—Humanitarian, February (Duckworth).—Scribner's Magazine, February (Low).—National Review, February (Arnold).—Knowledge, February (Witherby).—Fortnightly Review, February (Chapman).—Journal of Botany, February (West).—L'Anthropologie, tome ix. No, 6.—Observatory, February (Taylor).—Geographical Journal, February (Stanford).—Record of Technical and Secondary Education, January (Macmillan).—Zeitschrift für Physikalische Chemie, xxviii. Band, 1 Heft (Leipzig).—Bulletin of the American Mathematical Society January (New York).—Monthly Weather Review, October (Washington).

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THURSDAY, FEBRUARY 16, 1899.

TECHNICAL CHEMISTS AS "MADE IN GERMANY."

Chemische Technologie an den Universitäten und technischen Hochschulen Deutschlands. By Dr. Ferdinand Fischer, Professor in the University of Göttingen. (Braunschweig: Vieweg and Sohn, 1898.)

THIS is only a pamphlet of 54 pages, but it deals with matters of the utmost importance in the industrial struggle of this country with Germany. At intervals during the last twenty years the note of alarm has been sounded in this country with respect to the state of our chemical industries as compared with the development in this direction going on abroad, and especially in Germany.[1] The newspaper press has from time to time called attention to this matter; the modern revival in technical education has been largely influenced by such representations and, as a sign of the times, a special sub-committee was appointed by the Technical Education Board of the London County Council for the purpose of inquiring into the teaching of chemistry in London, the report of this committee having been published early last year. It is perhaps unnecessary to point out that, in spite of our recent efforts to recover lost ground, and to bring our chemical industries up to that position of supremacy which they held before the war of 1870–71, our educational machinery is still so far behind that of our Teutonic colleagues and competitors, that the German universities are now largely recruited by English and American students who are preparing for careers as chemical manufacturers. In stating that this condition of affairs is discreditable to our country, we are only paying our German friends that homage due to a nation which has all along recognised the supreme importance of the bearing of science upon industry. While we have been expending large sums in promoting "Polytechnics" of our own type, the Germans have been extending and improving their educational institutions so as to provide the highest and most specialised kind of instruction by the best experts that their country could supply. In brief, we have been "playing to the gallery" while the Germans have been addressing themselves to the private boxes and stalls; and if any doubt exists as to which kind of performance is producing the greatest effect upon the development of the chemical industries of the respective countries, we need only refer to our Patent Office records and the Board of Trade returns.

Under the title "Das Studium der technischen Chemie an den Universitäten und technischen Hochschulen Deutschlands," Dr. Fischer published a small work in 1897, from which it appears that for many years the question of introducing a general State examination for chemists has been undergoing discussion in German chemical circles. The subject has been further considered since 1897 by an Imperial Commission of inquiry (*Enquêtecommission*), composed of ministers and representatives of science and industry, and also by a union of German chemists, composed of professors and manufacturers, at several congresses. The results of these deliberations and the views of the various authorities have all been brought together in the present pamphlet by Dr. Fischer, and we recommend our chemical manufacturers to pay very serious attention to its contents.

In plain English, Germany has taken alarm at the symptoms of revival in industrial activity and in technical education going on here and elsewhere. It is not for the writer to say whether this alarm is well-grounded or not. But the Germans are justly proud of their supremacy in this branch of industry, and they are determined to keep well to the front. In a speech made in the Prussian Parliament, on March 8 of last year, Dr. Böttinger, referring to the subject of a State examination, said:—

"Wenn auch die Fragen noch nicht definitiv erledigt sind und noch vielfach schweben, so ist doch nicht zu übersehen, und wir können die Hoffnung aussprechen, dass wir hierin etwas Positives erreichen werden, was zur Hebung Deutschlands auf diesem Gebiete beitragen wird, so dass Deutschland bleiben wird, was es bisher war: der *primus omnium* auf dem Gebiete der Chemie."

We prefer to give this and the following extracts from the same speech in the speaker's own words, as much of their force would be lost by translation:—

"Ich möchte vor Allem an den Herrn Cultusminister die Bitte richten, diese Frage, betreffend die Weiterbildung unserer Chemiker, als eine dringliche zu betrachten, und die Geldfrage nicht zu sehr in den Vordergrund treten zu lassen. Meine Herren, wir müssen vermeiden, dass wir Chemiker zweiten Ranges erziehen; wir müssen erstreben, dass auch unsere deutschen Chemiker Chemiker erster Qualität sind, dass auch für sie das Wort 'made in Germany,' wenn ich so sagen darf, eine weitere Auszeichnung ist, wie überhaupt auch die Professoren und Lehrer an unseren Hochschulen das *primus omnium* sind und bleiben" (p. 14).

"Meine Herren, ich möchte doch betonen, dass Eile Noth thut, und diese Frage nicht auf die lange Bank geschoben werden darf. Denn die im gewissen Grade souveräne Stellung Deutschlands auf dem Gebiete der Chemie wird eifersüchtigst verfolgt, vor Allem noch von Frankreich, England und Nordamerika, wo man mit aller Energie gegen uns vorzugehen sucht" (p. 17).

"Ich will nicht alles das wiederholen, auf was ich im letzten Jahre hier verwiesen, und will nur betonen, es waren nicht leere Worte, nicht leerer Schall, sondern es waren ernste Wahrheiten, die auf persönlicher Beobachtung der Verhältnisse basirt waren. Auch im vergangenen Jahre hatte ich weitere Gelegenheit, mich zu überzeugen, wie ernstlich wir aufpassen müssen. Ja, ich möchte sagen, unsere deutschen Chemiker müssen alles aufbieten, damit es heisst: *Sauve-toi*" (p. 17).

The outcome of these discussions, as Dr. Fischer tells us in the preface to his pamphlet, is a very decided expression of opinion, both by the Imperial Commission and by the German Chemical Union, that the subject of technical chemistry or chemical technology is one of essential importance to their welfare as a manufacturing nation, and that it should be more taken up by the Universities than has hitherto been the case. It is pointed out that about 95 per cent. of all chemical students become technologists, and that with the exception of Berlin and Göttingen, which possess chairs of Applied Chemistry, very few of the Universities give special recognition to this subject.

[1] See a paper by the writer of this notice in NATURE, vol. xxxiv. p. 324.

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That the vaunted supremacy of Germany in chemical industry is not a mere political cry, prompted by patriotic bias, appears with stern reality in every speech or resolution recorded in the pages before us. Neither is there any hesitation in assigning this supremacy to its true causes; to State recognition of science and to the association of science with industry. The statement of Dr. Duisberg, adopted by the German Chemical Union at their Hamburg meeting, and presented to the Ministry, contains the following statements :—

"Die chemische Industrie Deutschlands, eine Quelle unseres Nationalwohlstandes, ist Dank den vereinten Bemühungen von Wissenschaft und Technik und Dank der Unterstützung, die ihr immer von Seiten der Reichs- und Staatsregierungen zu Theil geworden, auf eine Höhe gelangt, die den Neid aller mit uns auf dem Weltmarkte concurrirenden Nationen hervorgerufen und diese veranlasst hat, zur Hebung dieser Industrie und dieser Wissenschaft grössere Anstrengungen als bisher zu machen. . . . Es hiesse an unserer Nation Frevel begehen, wollten wir stehen bleiben und nicht Alles einsetzen, um im Wettkampfe der Völker auf chemischem Gebiete stets an der Spitze zu sein."

The same point, the marching of the men of science hand in hand with the technologists, is insisted upon by Dr. Böttinger in the speech already referred to, and this authority makes the further statement that (presumably in Germany) the want of technical chemists is even now perceptible. In a former speech Dr. Böttinger told the country that the total value of the exports of chemical products amounted in 1896 to 340 million marks: he pointed out that the larger portion of the raw materials used in preparing these finished products were imported into Germany from foreign countries, and he adds this very significant remark :—

"Diese Industrie ist eigentlich ursprünglich keine deutsche gewesen. Ein grosser Theil dieser Industrie hat zuerst in England und Frankreich existirt, sie ist dann aus jenen Ländern—besonders derjenige Theil, der sich auf die höhere, auf die rein organische Chemie bezieht—zu uns herübergegangen, und wird ausschliesslich oder fast ausschliesslich heute von uns der Weltmarkt mit deren Producten versorgt."

While unanimity prevails as to the desirability of founding chairs of technical chemistry in the German universities, the decision of the other question, the establishment of State examinations for technical chemists, is for the present deferred, since there is a division of opinion on this subject. Many of the professors of the universities and technical high schools have expressed their views, and it is obvious that the point will be a difficult one to settle when we find such names as those of Ostwald, A. v. Baeyer and Otto Witt, who are opposed to the examinational scheme, confronted by the names of Duisberg, Böttinger, Holtz, Lunge, &c., who are in favour of it.

Not the least striking feature of the speeches recorded in this pamphlet is the earnestness of the plea, put forward more especially by Dr. Böttinger, on behalf of the great national importance of chemistry, and the direct relationship of this science to various ministerial departments of the Imperial Legislature. The speaker even allows himself to be carried away by a poetical simile in comparing the unobtrusiveness of the chemist, as contrasted with his importance, to the aroma of the violet which flowers in concealment but delights man with its fragrance. He quotes also the sayings of English statesmen like Lords Beaconsfield and Rosebery, and Mr. A. J. Balfour, who have at various times called attention to German supremacy in the chemical industries. Reference is made also, to an article in the *North American Review*, the writer of which states that the nation which possesses the best chemists is bound in the long run to come to the fore-front. Dr. Böttinger distinctly suggests a falling off in German activity in the domain of inorganic chemistry :—

"Tüchtige anorganische Chemiker muss man heute be uns, ich möchte fast sagen, mit der Lanterne suchen; sie zu finden, ist oftmals vergeblich" (p. 33).

He deplores the migration of American students from the German high schools to Paris to learn this branch of the science; he even laments that the discovery of argon and helium did not proceed from one of their own laboratories, and he takes genuine alarm at the incursion made by the Americans into the manufacture of astronomical instruments, although, as he concedes, the glass for the lenses is of German make.

That Germany has taken alarm at the progress being made in other countries is manifest on every page of the pamphlet before us. The writer of this notice is inclined to believe that Dr. Böttinger and others take a pessimistic view of their own position; but the policy of "forewarned, forearmed" is obviously the moving principle of the present agitation. That which is of most importance to us here is the lesson conveyed by the manner in which our rivals propose to meet the competition which threatens the supremacy of their chief industry. They are urging the Government to establish chairs of technical chemistry in their universities. In this country there is a very widespread notion that technical chemistry cannot be taught in educational institutions at all. The leading chemical nation in the world has come to a different conclusion. If our chemists are anxious to know what this technical chemistry is, we commend to their notice a statement in the memorial of the German Chemical Union :—

"Technical chemistry as a branch of general chemistry is not, as is often erroneously supposed, the transference of chemical science to practical applications, but it is a science in itself . . . the flowering and thriving of which we owe to German chemical industry."

Dr. Duisberg and others lay it down as a general principle that the students of this subject should not be taken too deeply into all the details of technology, but that they should possess a general knowledge of raw materials, apparatus and processes; that they should be made to appreciate the difference between laboratory and factory operations; that the chemistry of technical processes should be taught in special courses of lectures, and the construction of plant illustrated by exact drawings and by inspection of works.

There are many other points in this compilation of Dr. Fischer's, which are full of significance for our own country; but enough has been culled from the pamphlet to show which way things are going in Germany. We could, I am afraid, supply our Teutonic

competitors with a painful number of illustrations of methods of how not to teach technical chemistry—illustrations of the very highest (negative) value. It is often, and justly, urged by the critics of our educational methods that we are the slaves of the examination system. But there is another demon that has come into our midst of late years, which also wants exorcising—the statistical demon. The committees of most of our educational establishments seem to have the one idea that success is measured by numbers of students turned out. The following statement, by Prof. Naumann, might profitably be stereotyped into an aphorism for the use of some of our technical instruction committees and kindred bodies :—

"Der deutschen chemischen Industrie kommt es nicht auf die Zahl der gelieferten Chemiker an, sondern auf ihre Qualität."

In concluding this notice, it is difficult to refrain from instituting a comparison between the methods adopted by the Germans and ourselves for dealing with the same problem of foreign competition. Instead of catering for the highest kind of work, and aiding existing teachers and institutions to do such work, we seem to prefer adopting a policy of broadcast smattering. If any bold advocate points to signs of decadence in any particular industry, the statistical juggler is always at hand to prove that he is mistaken. When we have achieved supremacy in any department and meet with competition, the educational machinery is the last line of our defence which is strengthened instead of being, as in Germany, the first. That we have been enabled in the past to achieve eminence without technical education is sometimes even now used as an argument that technical education is unnecessary. Our chemical manufacturers will do well to take Dr. Fischer's pamphlet, and the lesson which is contained therein, as a very serious sign of the coming struggle. So far as organic chemical products are concerned, the expression "made in Germany" is one of which that nation may now well be proud.

R. MELDOLA.

SEWAGE PURIFICATION AND SEWERAGE.

The Purification of Sewage; being a brief Account of the Scientific Principles of Sewage Purification and their Practical Application. By Sidney Barwise, M.D. (London), M.R.C.S., D.P.H. (Camb.), Medical Officer of Health to the Derbyshire County Council. Pp. xii + 150. (London: Crosby Lockwood and Son, 1898.)

Sewerage. The Designing, Construction, and Maintenance of Sewerage Systems. By A. Prescott Folwell, American Member Society of Civil Engineers. First Edition. Pp. x + 372. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1898.)

THE question of the hour is—What steps are to be taken for the disintegration of sewage without the addition of chemicals? Going a little outside this, Dr. Sidney Barwise has collected a certain amount of information which he thinks may be useful to his fellow medical officers of health. He points out that during recent years

"great advances have been made in our knowledge of the changes which sewage undergoes in purification, and not a few conclusions of wide-reaching importance established; and it is hoped that the presentation in this little work of some of the results thus obtained will be found useful by engineers and others, officials who wish to avail themselves of the latest researches of chemists and biologists upon the questions of sewage purification."

Although the work may be said in a certain sense to be an elementary text-book, it is something more, as the author has collected in handy though somewhat sketchy form a number of the more important observations on the chemistry and bacteriology of the decomposition of sewage. After describing sewage, its varieties, the changes that it undergoes, and its chemistry, Dr. Barwise indicates the effects of river pollution and the processes by which the water becomes purified; he goes on to give an account of "land treatment" of sewage, of precipitation, precipitants, and tanks, filtration or nitrification; and then describes in detail some of the special forms of sewage filters, especially Mr. Dibdin's filter, used in the experiments carried on by the London County Council; Colonel Ducat's filter, Garfield's coal filter, the Lowcock filter, and the Scott Moncrieff and Cameron filters.

Perhaps the most important feature of this work is that in which the author has attempted to compare the different sewages with which various experiments have been carried on in this country and in America. There can be little doubt that this question of comparative composition of sewage is one of great importance in determining what the various processes are capable of achieving, and therefore which process is best fitted for use in any special region. Taking the chlorine content as an index of the strength of sewage, it is evident, for example, that very different results would be obtained with any system in which an attempt is made to deal with, say, the Lawrence (Mass.) sewage, which contains 43 parts of 100,000 of total solids, and 4·8 parts of chlorine; or the Exeter sewage, with 54·4 parts total solids and 5 parts chlorine; and London sewage, which contains 123·5 parts total solids and 15·2 of chlorine; or, again, the Berlin sewage, which contains 218·3 parts of total solids per 100,000 and 21·8 of chlorine. There can be no doubt, however, that with many of the bacteriolytic methods described, remarkable results have been obtained, and statistics are given indicating the amount of purification brought about by each system; but the author very wisely in his conclusions points out that before it is possible to answer the question, "What processes shall we adopt to purify our sewage?" there must be information given as to the nature of the sewage, the facilities for disposal of sewage on land, the necessity that may arise for precipitation, the amount and nature of manufacturing waste, and the facilities that exist for complete oxidation of the effluent. The author has taken a considerable amount of trouble to collect trustworthy statistics, and were this part alone before the reader it would be worth reading; but apart from this, the book contains a considerable amount of information—in some instances loosely put together, and not always sufficiently fully set forth—and, taking the work for what it claims to be, it should prove not only of interest but of assistance to those who are engaged in advising sanitary authorities as to what measures it will be necessary to

take in order that the requirements of the various Rivers Commissioners may be complied with.

The second book is drawn up on essentially different lines; it is written by a practical engineer, and is largely the outcome of his own experience, though he does not pretend to confine his statements to those based on his own personal observation. On going over the work one cannot but be struck by the fact that, although it is intensely practical, and should prove of very great assistance to young engineers, clerks of works, and in fact to all who have to do with sewer construction, the information is so arranged that it may be utilised in the classroom for the instruction of engineering pupils; for the way in which the author treats the three parts of his subject—designing, construction, and maintenance—must commend itself not only to the practical engineer, but to the teacher in the technical institute and the engineering college.

As regards the requirements of a system of sanitary sewerage, Mr. Folwell lays down the two propositions: (1) that sewage, and all the sewage, be removed without any delay to a point where it may be properly disposed of; (2) that it be so disposed of as to lose, permanently, its power for evil. He describes in order the various methods that from time to time have been adopted to attain these ends. Dry sewage methods and systems, pneumatic systems, water carriage systems, combined and separate systems—first speaking generally, and then giving in some detail the principles involved in, and the data required for, successful sewage disposal, as regards amount of sewage, the flow in sewers, flushing and ventilation, the design, detailed plans, specifications, contract estimate of cost, &c. In a second part, devoted to construction, he goes into the question of preparation, laying out the work, oversight and measurement of work, and practical sewer construction. In the third part he speaks specially of maintenance, of house connection and drainage, and of the maintenance of the sewer itself, dealing specially with flushing and cleaning.

Many parts of this work will be useful to engineers and surveyors in this country, as the question of sewage disposal is, in many of its aspects, the same in America as in Europe, and the following "aphorisms" appeal to all alike: "Many diseases may be contracted by taking into the stomach certain germs which are found to be excreted by those already sick of such a disease, and these germs will exist for days in sewage having any amount of dilution"; "ordinarily sewage does not putresce until from twenty-four to sixty hours after its discharge"; "the only true destruction of the dangerous characteristics of sewage is that effected by oxidation and by removal of the disease-germs"; "oxidation does not destroy but merely transforms the putrescible organic matter into harmless mineral compounds"; and so on.

It is very strongly insisted that corporations are perhaps more inherently selfish than are single individuals, and that consequently corporations have little hesitation in offending their neighbours, or interfering with their hygienic conditions, if they can only manage to do this to their own advantage from a health point of view; and we are glad to see that he insists that engineers should carefully guard themselves against fostering this weakness of those who are their clients. As an example of the different conditions that hold in America and in this country, one has only to turn to the consumption of water in certain of the large cities to know that in most cases the American sewage is far more dilute than the sewage running in the drains of our own large cities. From a table given, including twenty-five American cities, it is seen that there are only three that have a water consumption of under fifty-five gallons per head, whilst eleven cities consume over one hundred gallons per head—from one hundred and twelve to one hundred and ninety-nine gallons; then, too, the consumption is rising steadily from 10 to 100 per cent. every ten years, an increase that is marked throughout. As a result of this the quantity of sewage is steadily increasing, and of course it is becoming more dilute. As one would naturally expect, also, the quantity of storm water is, in many parts of America, a far more important one than it can ever be in this country. We are thus not surprised to see that in Toronto, in 1891, gaugings in different districts made over a period of three days gave a discharge varying between fifty-three gallons per head per diem to three hundred and sixteen gallons. The author remarks that Mr. Gray, who gives these figures, offers no explanation for the high average indicated by this last figure. The very fact that we have these differences, however, should render the book more valuable to English engineers. The suggestions offered in connection with the problem of dealing with these enormous quantities of sewage, may afford hints for dealing with the much smaller quantities that have to be coped with on this side of the Atlantic.

DR. DREYER ON DARWINISM.

Peneroplis, eine Studie zur Biologischen Morphologie und zur Species-frage. Von F. Dreyer. Pp. ix + 119. Plates v. (Leipzig: Engelmann, 1898.)

DR. DREYER'S work on *Peneroplis* is of great interest, not only because of the valuable observations which it contains, but as an indication of the way in which an increasing number of German zoologists regard the problem of animal evolution.

The main part of the work is devoted to a description of the form-varieties of shells of *Peneroplis*, as seen in a sample of sand from the shore of the Red Sea. The description is illustrated by figures of more than two hundred specimens, chosen as examples of the various ways in which the "typical" spiral form may be departed from.

Dr. Dreyer has rightly called his essay "eine Studie zur Species-frage"; for there is no doubt that the conception of a species, which is necessary in attempting to deal with many problems of modern biology, must be based on a knowledge of the whole series of varieties exhibited by the species. And further, this knowledge must be obtained in the way in which Dr. Dreyer has obtained it, by the careful study of a large number of individuals, taken in the first instance at random. Many of the distorted ideas about animal variation which are evident in writings on the subject arise from the belief that variation can be profitably studied in museums, by comparing "typical" specimens with the one or two striking deviations from the type which the curator has chosen to exhibit. There is, however, an additional element, essential

to a right conception of a species; and this Dr. Dreyer has not given. He gives admirable drawings and descriptions of a great number of form-varieties, but he does not tell us how often each variety occurred in the 25,000 specimens examined. A table, showing the frequency with which every variety drawn was actually observed, would have added so greatly to the value of the work that it would have been well worth the labour involved in making it.

The essay is apparently published in the hope of stimulating others to undertake an experimental investigation of some of the factors which determine the shapes of rhizopod shells; and the author seems to have undertaken his study of *Peneroplis* as a preparation for experimental work of the same kind. Every reader will wish Dr. Dreyer a full measure of success in the difficult task he has set himself to accomplish.

For the reason just given, little attempt is made to use the observations recorded as a basis for generalisation; but the last chapter contains certain criticisms of current biological doctrines, which seem based upon fundamental misconceptions. It is difficult to convey an exact idea of a writer's meaning by quoting short extracts, but the following passages express Dr. Dreyer's position fairly well. In discussing the conception of animal evolution he says:

"Gesetzt aber auch, die genealogische Entwicklung im ganzen oder in diesem oder jenem ihrer Zweige befände sich vollständig und sicher in unserem intellektuellen Besitz, so hätten wir hiermit eine Entwicklung, die wir naturgesetzlich eben so wenig verständen, wie die einzelnen Lebensformen, aus denen sie sich zusammensetzt."

It is, of course, perfectly conceivable that we might know the exact genealogy of all living species, or of some of them, without knowing anything of the process by which the modifications undergone by the ancestral species has been effected; but the statement that species are susceptible of modification in the course of generations, if it is true, is itself the statement of a natural law; so that Dr. Dreyer's meaning is difficult to discover.

Darwin's hypothesis concerning the process by which specific modification has been effected is dealt with as follows:

"Nun ist die Selektionslehre einmal falsch, denn sie steht in krassem Widerspruche zur Wahrscheinlichkeitsrechnung, und wenn sie richtig wäre, würde sie ein Verständniss der uns als leibhaftige Probleme entgegentretende Organismen im nichts berühren, ebensowenig wie . . . diese oder jene Äste eines Baumes damit 'erklärt' sein können, dass sie der Gärtner nicht weggeschnitten hat.

"Wenn also die Ergebnisse der Descendenz forschung problematisch sind und, wenn sie sicher wären, oberflächlich, so ist die Selektionslehre in sich hinfällig, und wenn sie richtig wäre, wäre sie nichtig.

"Es wird nunmehr Zeit dass die jung aufwachsene Biologie von dieser ihrer englischen Krankheit erhole und mannbar werde."

It would be interesting to have a more detailed exposition of the author's reasons for saying that the theory of Natural Selection is in contradiction to the laws of Probability. No case has yet been described in which the phenomena of variation and inheritance have been shown not to obey the law of Probability. If Dr. Dreyer knows of such a case, he would do well to publish his knowledge.

The remainder of the criticism is worth serious notice, in spite of the bad taste shown in the last paragraph, because the objection to the use which is often made of the theory of Natural Selection is perfectly just. It is quite true that a plausible hypothesis about the utility of an organ or of a function is not a proof that it has been produced by natural selection; and when such a phenomenon as Death itself is "explained" by ingenious guess-work of this kind, one feels that much must be forgiven to a hostile critic. But these things are no essential part of the Darwinian theory. Darwin laid down two fundamental propositions—*first*, that the differences in structure between individual animals of the same race or species are associated with differences in the death-rate and power of producing offspring, so that the number of descendants left by an individual is a function of its structure; and, *secondly*, that the effect of differential fertility, associated with structural differences, is often sufficient to change the character of the race or species in the course of successive generations.

These are essentially physiological propositions, which admit of direct experimental verification or disproof. The experimental testing of these two propositions would open up a fascinating field of knowledge, which has been left almost untouched since Darwin himself wrote.

Darwin was so fully occupied in forcing men to recognise the broad fact of structural variation, that he had little time to demonstrate the relation between variation and death-rate. Nevertheless, naturalists have been content for forty years to rest a great generalisation on his work alone, without themselves attempting to amplify it by direct observation and experiment. It is time that a systematic study should be made of the relation between structural abnormality and death-rate, under definitely determined conditions of environment, in a large number of species. If the relation postulated by Darwin generally exists (as the writer believes), it is time that it should be properly demonstrated. If it does not exist, it is time that the belief in natural selection should be given up.

But it is the business of naturalists to formulate the processes of nature as well as they can; and whether the process of Natural Selection interests Dr. Dreyer or not, we ought to want to know certainly whether it occurs. The statement that such a process does affect animals generally, is either a natural law of great importance, or it is untrue. If it is true, it is as absurd to call it "nichtig" because it does not formulate *all* the processes of a living organism, as it would be to call it useless because it does not enable one to foretell to-morrow's weather.

W. F. R. WELDON.

OUR BOOK SHELF.

Elements of Sanitary Engineering. By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. Pp. 216. (New York and London: Chapman and Hall, 1898.)

THE author of this book deals with the whole range of sanitary science, including an historical notice of sanitation from the time of the Israelites in Egypt; the classification of diseases; statistics of mortality as

affected by sanitation; bacteriology; the effect of filth, impure drinking water and foul air on health; water supply, storage and filtration; construction of reservoirs and supply of water to towns; sewerage, both for cities and houses; and the disposal of garbage and town refuse. In the introductory chapter the elements of sanitary science which are essential to sanitary engineering are briefly outlined, and in the historical notes it is shown how the filthy habits of the people in early times led to direful epidemics of plague. It is pointed out that "the teachings and practice of the Christian Church during the Middle Ages regarded cleanliness as one of the luxuries which was inconsistent with godliness, while bodily filth was considered as a work of inward piety and holy sanctification. The example set by the monastic orders was imitated by the people at large; bathing was unknown, houses and clothing were filthy, and the streets served as receptacles for garbage and human excreta." Some interesting statistics are given to show how the death rate has decreased as sanitary science has advanced. The annual death rate of the population of London in the latter half of the seventeenth century was nearly 80 per thousand; in the eighteenth century, about 50 per thousand; and soon after the middle of the nineteenth century, about 24 per thousand; and now ranges about 20·5 per thousand. An efficient system of sewerage and water supply has been known to reduce the death rate in large towns in England and the continent from typhoid, from a rate of 2·2 per thousand inhabitants to 0·4 per thousand. The cholera epidemic which visited Hamburg in 1892, caused 8976 deaths, being at the rate of 134 per thousand in Hamburg, where the water supply was proved to be impure and to contain the cholera bacillus; while in Altona and Wandsbeck, adjoining the city, where the water was properly filtered before being supplied, the rate was respectively 23 and 22 per thousand.

This book, which is written for American students of sanitation, does not contain anything that is not known to sanitary engineers of this country. Naturally, in such a small compass it was not practicable to deal with any of the subjects treated in an exhaustive manner; nor can the work be regarded as a text-book, but rather as a well-written and able digest of matters which come within the range of the sanitary engineer.

La Cytologie Expérimentale. By A. Labbé. Pp. viii + 187. (Paris: Carré, 1898.)

THIS neat little book has the attractive form and style which characterises many French science manuals, and shares with them the defects inherent in any attempt to convey the difficult results of refined biological research in short paragraphs, even when written in the clearest of languages. At the same time we must add that it does not profess to be a complete text-book or treatise on the subject, and it is perhaps best described as a series of notes on some modern results of the study of the cell, by a zoologist. Artificial protoplasm and artificial karyokinetic figures are misleading terms to the beginner, and the scraps of information here gathered can be of little or no use to more advanced readers. The action of physical and chemical agents on the structure, metabolism, and movements of the cell seems curiously incomplete, in a French work, without reference to the yeast-plant; and although the notes on chemotaxis are interesting, they might have been rendered more valuable had the botanical side of the question been more fully dealt with. Indeed, throughout the work we notice a lack of appreciation of the work of plant-physiologists, *e.g.* as regards geotropic and heliotropic curvatures—no doubt inevitable where the author is a zoologist, the domain of each subject being now so wide that no one writer can deal adequately with both. Klebs' work on the effects of the environment in modifying the reproduction of algæ, for instance, is not mentioned.

The reciprocity between nucleus and cytoplasm; experimental modifications of cellular reproduction; adaptation to the environment; "tropisms and tactisms"; and cellular differentiation, are the other subjects dealt with.

While finding fault to the extent we have done, it is only fair to add that the subject-matter, so far as it is treated, is fascinating from every point of view, and many of the facts given are extremely interesting—*e.g.* those concerning the artificial separation of the nucleus from animal ova, those on "*cyto-symbiose*" and adaptation to parasitic life, those on intercellular connections, &c. Much more ought to have been said, we think, concerning the discoveries of botanists, especially in connection with the last two subjects.

The illustrations are numerous, well executed, and to the point; and praise must be accorded the glossary and the index to the bibliography, so far as it goes. Finally, we welcome this little book of notes, in the hope that it will be the forerunner of a more masterly treatise on an important and fascinating subject.

Studien über Hirsche (*Gattung* Cervus *im weitesten Sinne*). Heft I. Untersuchungen über mehrstangige Geweihe und die Morpholngie der Hufthierhörner im Allgemeinen. By Dr. H. Nitsche. Pp. xi + 102. Plates xii. (Leipzig: W. Engelmann, 1898.)

WHETHER the work of which this first instalment is before us is intended to be a monograph of the *Cervidae*, or whether it is to be restricted to morphological considerations, future parts will decide. The present section deals solely with the morphology of antlers and their relations to the horns of other ruminants. In discussing antlers, most English zoologists of recognised position have confined their attention to normal examples. Not so Dr. Nitsche, who is apparently of opinion that the clue to the homology of the diverse structure of these appendages in different species is to be found in abnormalities, especially such as display a double or triple beam. Such abnormalities are classed under four types, in three of which the additional antler is more or less like the original form, while in the fourth the additional and normal portion together resemble an ordinary antler. Whether the result of these studies will have any important bearing on the classification of the *Cervidae*, cannot well be considered till the appearance of the later parts.

In the meanwhile attention may be directed to the author's very lucid account of the distinctions between the cranial appendages of the Pecora; such distinctions being admirably illustrated in Plate xii. To put it shortly, the author, in opposition to the view of M. Lataste, regards antlers as true outgrowths, or apophyses, from the frontal bones; these processes are at first covered with hairy integument, after the shrivelling-up and removal of which the exposed bare portion eventually falls off from necrosis at the base. In the following year the whole process of growth and shedding is repeated. On the other hand, in the remaining three families of the Pecora, to wit, *Giraffidae*, *Antilocapridae*, and *Bovidae*, the appendages originate as independent bony epiphyses, which become subsequently welded to the frontals. In the giraffe the horns, as these appendages should be called in all the members of the group, are clothed only with hairy skin. In the prongbuck a deciduous and forked horny sheath is superadded to the hairy skin. On the other hand, in the *Bovidae*, the hairy skin is lost, and the bony core is covered simply with a non-branched and non-deciduous horny sheath. The epiphysial origin of the horn-cores of the *Bovidae* is illustrated by a figure of the frontal region of a young chamois.

These distinctions between antlers and the different types of horns are certainly the clearest and neatest that have come under our notice; and they naturally lead the author to the conclusion that the *Cervidae* form one group, and the other three families mentioned a second division of the Pecora. If his views obtain acceptation, they refute the late Prof. Garrod's theory of the near relationship of the musk-deer to the *Bovidae*.

Whether or no his predilection for abnormalities will bear any good fruit, the author has evidently devoted much pains-taking labour to the present fasciculus; and the issue of the remaining parts of the work will be awaited with interest. R. L.

Recent Advances in Astronomy. By A. H. Fison, D.Sc. Pp. vi + 237. (London: Blackie and Son, 1898.)

IN the course of half a dozen essays the author of this volume of the "Victorian Era Series" has attempted to give an account of a few of the more interesting problems of modern astronomy. While the book is admirably written throughout, the subject-matter is in some respects not sufficiently up to date. For example, in the essay on the "life of a star," which is otherwise exceedingly interesting, there is practically no reference to the spectroscopic evidence bearing on the subject; and again, in that on the "analysis of starlight," there is no account of the different kinds of stellar spectra and their probable relationship to each other, most of this chapter being concerned with motion in the line of sight.

One of the best essays is that on Mars, which summarises what we know of that planet, as well as the various speculations to which such knowledge has led.

The book is notably free from errors for a first edition; but we may point out that the discovery of carbon in the sun was not made in 1887, as stated on p. 187, but was announced by another investigator altogether in 1878.

It is unfortunate that, either for want of time or opportunity, the author has not gained a closer acquaintance with recent spectroscopic investigations. Had he done so, his book would have been much improved. Nevertheless, the selected subjects are treated in an able manner, and the book deserves to be widely read.

Among the Celestials. By Captain Francis Younghusband, C.I.E. Pp. 261. (London: John Murray, 1898.)

THE inspiring volume entitled "The Heart of a Continent," in which Captain Younghusband gave a straightforward record of ten years' travel in Manchuria, across the Gobi Desert, through the Himalayas, the Pamirs, and Chitral to India, was reviewed at length in these columns in 1896 (vol. liv. p. 130). The present volume has been abridged from the original work, by omitting geographical details which, though of service to geographers and travellers, are not of interest to the general public. The previous book will be published in two parts. The first part, now before us, deals with Captain Younghusband's travels in the Chinese Empire, a chapter on the outlook in Manchuria being added. The second part will describe experiences and impressions obtained during travels in the borderland between British and Russian territory in Central Asia.

There should be many readers for Captain Younghusband's interesting narrative in the form it is now presented.

A Cotswold Village: or, Country Life and Pursuits in Gloucestershire. By J. Arthur Gibbs. Pp. xvi + 431. (London: John Murray, 1898.)

FIELD naturalists, and all other admirers of natural life and scenes, will read this volume with pleasure. The book is of the gossipy kind, and village characters and customs figure prominently in it; but many keen observations are recorded, and the descriptions of pastoral scenes will delight all who love the country.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Production of Magnetisation by Circularly Polarised Light.

IN NATURE for January 5, Prof. Fitzgerald points out that a beam of circularly polarised light sent through a substance absorbent in consequence of syntony with the vibration ought to produce magnetisation of the substance. The result of the experiments he has set on foot will be awaited with much interest.

In the *Proceedings* of the Royal Society for February 17 of last year Prof. Fitzgerald pointed out also that the Zeeman and Faraday effects are related phenomena. I may mention that in the *Phil. Mag.* for December 1890, I gave a very slight sketch of experiments I had carried out from time to time during several years previously, with the view of discovering the effect which theory had seemed to me to prove ought to be produced by the passage of circularly polarised light through a medium showing the Faraday effect. I have made many experiments of this kind with a bar of Faraday's heavy glass, looking for the production and disappearance of a magnetic field (with the excitation and quenching of the beam) by means of an induction coil wrapped round the bar. Calculation shows that the effect in such a case should be very small—so small as perhaps to be quite inappreciable. The investigation is, however, being resumed with improved apparatus and arrangements which I hope may not be entirely without result.

ANDREW GRAY.

Magnetic Perturbations of the Spectral Lines.—Further Resolution of the Quartet.

FOR some time past I have been in hope that, with the strong magnetic field now at my disposal in the Physical Laboratory of the Royal University of Ireland, I might perhaps be able to effect some further resolution of the spectral lines. For example, in the case of a line which is converted into a triplet (normal type) by a magnetic field of strength 20,000, or thereabouts, it is possible that each constituent of this triplet may become further resolved into a doublet, or a triplet, when the strength of the field is increased to 40,000 or 50,000 C.G.S. units.

Although I cannot yet affirm that the normal triplet becomes further resolved in very intense fields (but symptoms of a further resolution into doublets are sometimes seen), yet, on the other hand, it has been placed beyond all doubt that the "quartet" form becomes further resolved when the strength of the field is increased.

The quartet form, it will be remembered, consists of two strong side lines with two fainter lines between them—the latter pair corresponding to the middle line of the normal triplet. When the strength of the magnetic field is gradually increased, the side lines begin to separate into pairs; and ultimately, what was at first a quartet stand forth as a sextet of well-defined sharp lines. We may take it, therefore, that the quartet form has ceased to exist as a distinct type, except for this one peculiarity, viz. that in it the separation of the middle pair is considerably greater than that of the side pairs.[1] The exact ratio of these separations I have not yet determined with precision, but I hope to give measurements on this and some other matters at an early date.

It is not to be understood that this further resolution raises any new difficulties in the way of theoretical explanation, for, as I have already pointed out (*Phil. Mag.*, February 1899), the purely precessional perturbation of the orbit which gives rise to tripling pure and simple is by no means likely to be unaccompanied by other subsidiary perturbations of more or less intensity, such as oscillations of the plane of the orbit, apsidal motions, and so on, and such perturbations as these explain the existence of types other than the normal triplet. In fact, things appear very much more natural, as well as more interesting, now that we know that the triplet pure and simple is likely to become the exception rather than the rule. THOMAS PRESTON.

Dublin, February 9.

[1] On the contrary, D_2 is a sextet of *equally spaced* lines.

The Density of the Matter Composing the Kathode Rays.

IN a note which appeared in NATURE of January 19, I indicated a method by which an approximate limiting value could be deduced for the density of the matter composing the kathode rays. The result arrived at was that this must be small compared with 10^{-15} grams per cubic centimetre. This estimate seems to be confirmed by results recently published by E. Riecke (*Wied. Ann.*, 66, p. 954) on the reaction-pressure exerted on the movable kathode-vanes of an electric radiometer. A theoretical investigation leads the author to the result, that this pressure is equal to mu^2, in the notation of my former note (m, mass per unit volume; u, velocity of the particles). His numerical results give an average of about ·04 dynes per square centimetre for the pressure, and he deduces for u, theoretically, the value $9{\cdot}6 \times 10^9$, or, say, 10^9 roughly. Using these numbers, m comes out about 4×10^{-20}.

Queen's College, Belfast, February 11. W. B. MORTON.

Earthquake Echoes.

AN earthquake disturbance, as recorded at a station far removed from its origin, shows that the main movement has two attendants—one which precedes, and the other which follows. The first of these by its characteristics indicates what is to follow, whilst the latter in a very much more pronounced manner repeats at definite intervals, but with decreasing intensity, the prominent features of what has passed. Inasmuch as these latter rhythmical but decreasing impulses of the dying earthquake are more likely to result from reflection than from interference, I have provisionally called them *Echoes*. Although I see an explanation for the orderly arrangement and features of the precursory vibrations, it is sufficient if I confine my remarks in this note to the reverberations which apparently succeed an earthquake.

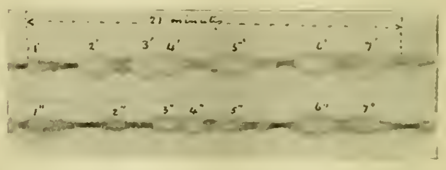
If it can be shown that our world resounds with earthquake echoes, hypotheses at once suggest themselves as starting-points for new investigation.

It is, therefore, of importance that before the idea of earthquake reverberations should be crystallised, the evidence we have of the supposed vibrational repetition should be carefully scrutinised, and that opinions should be expressed respecting the interpretations of observations like the following. When an earthquake is comparatively small, and has originated as a single effort at no great distance (one or two thousand miles) from the observing station, the seismogram shows a single set of preliminary tremors, of short duration, a single set of pronounced vibrations corresponding to an irregularly delivered originating impulse, and finally a series of concluding vibrations which rise and fall in value every three or four minutes. That which appears on a seismogram as a two-blow earthquake terminates with dual reinforcements. As illustrative of this, I may refer to the Isle of Wight seismogram of the South Indian Ocean earthquake of August 31, 1898, copies of which have been sent to the members of the Seismological Investigation Committee of the British Association, and to their various co-operating stations We have apparently here two large disturbances followed by pairs of echoes. If we closely examine the first pair of these responses (the second pair being too small to exhibit details), we find that its subdivisions roughly agree in character with those observable in the collection of movements which make up the primary impulses. Calling the first maximum 1, and its following echoes 1′, 1″, and 1‴; and the second maximum 2, and its following echoes 2′, 2″, and 2‴, the time intervals expressed in minutes between these various phases are

1 to 1′ = 12.	1′ to 1″ = 8.	1″ to 1‴ = 4.
2 to 2′ = 10.	2′ to 2″ = 7·5.	2″ to 2‴ = 3·5.

In considering these intervals it must be remembered that 1 is greater in amplitude and period than 2, whilst 1′ is similarly greater than 1″, &c. Now, seismological observation appears to point to a result that is difficult to accept, viz. that the smaller the amplitude of a wave, and the shorter is its period, the higher, apparently, is the velocity of its propagation. Should this be so, then it follows, as is indicated by the above series of intervals, that the smaller echoes should return more quickly than those which precede them. A much more certain observation is made when this earthquake is regarded as resulting from a single impulse, and what has been treated as the second maximum is examined as its echo. We then see that the five crests, constituting what has been called the first blow or impulse, are repeated in what has been called the second blow by a five-crest echo, the intensity of each component corresponding with that of its primary. After this we get another five-crest group, followed by two groups each of four crests, beyond which point rhythmical recurrence is lost. A very good illustration of what may be multiple echoes is found in the Isle of Wight seismogram for June 29, 1898. This is a very large earthquake, which probably caused the whole of the earth to pulsate, and its preliminary tremors indicate that it originated at a very great distance. It had a duration exceeding three hours. The main disturbance shows more than fourteen maxima of motion which have a fairly symmetrical arrangement to the right and left of a central dividing line.

Between these first movements and the first set of responses, which commence suddenly, a faint but very uncertain likeness may be seen. When, however, we compare the responses, amongst themselves they apparently show a repetition in form and a uniformity in their time of recurrence that can hardly be the result of accident. To facilitate such a comparison two series of these concluding vibrations are here photographically reproduced, the first series being placed above the second.



It will be noted that the triangularly-headed echo 1′ is not unlike 1″; its spherically-formed successor 2′ is repeated in 2″; and so we may continue through the series until we reach the gourd-formed 6′ and 7′, reflected in corresponding shape by 6″ and 7″. Other points of likeness may be seen between 4 and 5 and between 5 and 6. I may add that if the photogram had been made longer, then three groups of waves would have preceded 1′, which would correspond in form and time with three groups preceding 1″.

The time intervals between these corresponding groups are respectively as follows: from 1′ to 1″, 2′ to 2″, &c.: 30, 31, 30·5, 31, 31, 29 and 28 minutes. We here appear to be dealing with a series of vibrational groups, each of which took almost exactly half an hour to travel to and fro between two reflecting surfaces or districts. If the waves were compressional in character, the distance between these surfaces would be about 8000 kms.; but if they travelled with the velocity of the waves of shock, this distance would be reduced to something under 3000 kms. From their period and amplitude it is probable that the distance lies between these values.

The main point at issue, and the one to be answered before we enter into further speculations, is whether seismograms showing this musical repetition can be interpreted in the manner here suggested. The concluding vibrations of an earthquake have usually been regarded as a disorderly mob of pulsatory movements resulting from spasmodic impulses, which gradually grow feebler as the activity at a seismic centre becomes exhausted. The question before us is whether an earthquake dies by a process analogous to repeated and irregular settlements of disjointed materials, or whether it is simply a blow or blows which come to an end with musical reverberations inside the world. For the present my opinion inclines to the latter, and I see in the earthquake followers the likeness of their parents.

The observational confirmation of the existence or non-existence of these echoes requires a special arrangement of apparatus, installed in a dry, well-ventilated room, having a proper site, and free from tremors. In the dark, damp stable where I work, I regret to say that the frosty nights have brought with them vigorous and persistent tremors, and as a good observing season has now commenced, beautiful seismograms are being spoiled. The last to suffer was that of a magnificent set of waves which arrived from Mexico on the night of January 24. JOHN MILNE.

February 1.

Is Natural Selection all Metaphor?

The Duke of Argyll, in his reply to Mr. Herbert Spencer, says "in the Darwinian theory there is no selector" (Nature, February 2, p. 317). Though we have not yet discovered a principle or factor which plays the part of the breeder in nature, it by no means follows that "natural selection" is "all metaphor," nor yet, as has been often stated, an altogether misleading phrase. The rôle of the breeder or artificial selector is, I believe, often misunderstood. If we consider what the art of breeding mainly consists in, we may come to the conclusion that even the phrase "artificial selection" is, to a considerable extent, misleading and metaphorical. It seems to me the art of breeding consists mainly in two things, viz. (1) producing prepotency, and (2) preventing intercrossing. Prepotency is produced and maintained by inbreeding. The object of preventing intercrossing is to arrest, as far as possible, variation and reversion. If it can be shown that in nature prepotency often arises either as a sport or through inbreeding, and that prepotency by arresting the "swamping effects of intercrossing" plays the part of the fences of the breeder and the cages of the fancier, we shall be justified in looking upon prepotency as a "selector," and in finding more than metaphor in the phrase "natural selection." We already know that amongst insects a sport may displace the parent form; and if, instead of searching for evidence of intersterility as suggested by Romanes, we search diligently for evidence of prepotency, we may ere long discover the "selector"—the factor that in nature, under the control of utility, plays the part of the breeder.

J. C. Ewart.

Geometry *versus* Euclid.

To a great many people the assertion that the teaching of geometry from Euclid's book in the schools—and especially in the preparatory schools—is a positive hindrance to the teaching of science will be regarded as paradoxical, if not, indeed, erroneous. Yet I *do* make the assertion; and I base my confidence in its truth mainly on the experience which I have gained as an examiner of boys who have finished their school education.

Geometry is about the oldest of the sciences, and Euclid's venerable work bears all the characteristics of a book compiled at a remote time when such science as existed was a kind of mysterious possession in the hands of a few experts to whom intricate technicality of language was (as Swift would say) a principle of great emolument. The inventor of a new science is only too prone to build it up with an elaborate and technical system of definition and nomenclature, hoping thereby to emphasise its importance and to cultivate a wholesome awe in the uninitiated. In this way is established a particular kind of jargon which becomes distinctive of the science, and of its professional exponents.

The growth of such a system is well exemplified in other domains than that of science. For example, there is not, I think, any game in vogue in England which possesses such an elaborate technical jargon as that of golf, and the rule which is always observed in such matters is here strictly recognised—viz. the less the intrinsic merit of the subject, the more elaborate the accompanying jargon.

We are all very familiar with the Euclid jargon. Some of us, indeed, have somehow come to believe that no proof of a proposition can possibly be valid unless it is presented in this orthodox form.

A modern Euclid for the use of schools is sometimes a model of soul-destroying systematisation. I have before me such a work in which the process of arriving at the conclusion that two angles of a triangle are equal if the sides opposite to them are equal, reminds me of the process of walking across a lawn over the surface of which have been stretched innumerable threads in various directions for the purpose of tripping up the unwary.

The number of heads under which a well-taught modern boy will arrange the most simple proposition is wonderful: "general enunciation," "particular enunciation," "hypothesis," "construction," "demonstration," "conclusion" must all figure, or else the proof is "no good." Only a boy who has been careless says, "if two triangles have three sides of the one equal to three sides of the other, the triangles are equal in all respects"—a very simple truth which I received once in the following form from a boy who was much more careful of the orthodox jargon: "if two triangles have two sides of the one respectively equal to two sides of the other, each to each, and likewise also their bases, or third sides, equal, then shall the three angles of the one triangle be equal to the three angles of the other triangle, and the triangles shall be equal in every respect."

Observe that in the Euclid jargon nothing ever simply "is"—it always "shall be."

In finding fault with Euclid as a book for beginners I have, of course, no right to charge it with the enormous number of definitions, and the dissertations on the various kinds of propositions ("positive," "contra-positive," &c.) which some of the school-books set right in front of the beginner before the first proposition of the first Book is reached.

Still, it is by no means the paragon of logical clearness that it is commonly alleged to be. Take, for instance, its very first definition: "a point is that which has no parts." This is an excellent definition of *absolute nonentity*, but not of anything that can be pictured in the mind. Some editors of Euclid, feeling that there is something wanting in this definition, have (they think) vastly improved it by saying that "a point is that which has *position* but no magnitude"—as if *position* is more easily grasped than *point*. Then again (still at the threshold of the subject) the beginner is taught to believe that he is getting a very definite conception of a right line in the definition, "a right line is that which lies *evenly* between its extreme points"—as if the meaning of "evenly" is at once beyond question.

But of all the elementary conceptions in Euclid that of an *angle* is the one which most puzzles a beginner, and remains unrealised for the longest time. "An angle is the *inclination* of two straight lines to one another." Here again we have one obscure term defined by another equally obscure; and we know by experience that, unless the conception is presented in a very different way, the obscurity will be permanent.

Moreover, it is possible to point out a self-contradiction in Euclid. Thus his definition of a circle makes it to be a disc—"a circle is a plain figure *bounded by one line* called the circumference"—so that, clearly, the whole of the space inside (or, possibly, outside) the circumference *is the circle*, whose mere boundary is the circumference; and, if so, two circles can, of course, intersect in an infinite number of points—over an extensive area, in fact; but this is contradicted by Euclid in the tenth proposition of Book III., according to which one circle cannot intersect another in more than two points.

These, it may be admitted, are comparatively minor considerations, and the defects might be corrected by judicious teaching.

It is chiefly in the way in which the fifth and sixth Books of Euclid are apprehended by boys that the necessity for a change in the system of teaching is to be seen.

Those mediæval technicalities "duplicate ratio," "subduplicate ratio," "sesquiplicate ratio," and some others are drummed into the heads of boys as if they were terms of the utmost scientific importance. What mathematician ever uses such terms, or even thinks of them in his investigations?

The simple and extremely important fact that the areas of two similar figures are to each other as the squares of corresponding linear dimensions is presented to the beginner in the nineteenth proposition of the sixth Book in the words "similar triangles are to one another in the duplicate ratio of their homologous sides"—a statement which is singularly deficient in accuracy inasmuch as it omits to say precisely what two qualities or quantities connected with the triangles are thus related (colours, shapes, sizes, or what?); and the result is absolute confusion in the minds of a very large number of boys.

Let me illustrate this by a few *bona fide* examples. In reply to the question, "What are similar triangles, and what is the relation between their areas?" the following answers were received:—

(1) A triangle is similar to another triangle when their sides are proportional, and when the homologous sides of one are in duplicate ratio to the homologous sides of the other.

(2) If two triangles have the sides about an angle in each proportional and the other angles of the same affection, the triangles are similar. Similar triangles are proportional to the bases on which they stand, and are to one another in the duplicate ratio of their homologous sides.

(3) Similar triangles are those which are equal in area to each other and are in the same proportion to each other as the duplicate ratio of their homologous sides.

(4) When the angles are similar the areas are similar, when the areas are similar the angles are similar, when the sides are similar the areas are similar.

(5) Similar triangles are equal in all respects—sides equal to sides, angles equal to angles, areas equal to areas. Similar triangles are to each other as their bases.

(6) Similar triangles are to one another in the duplicate or subduplicate ratio of their homologous sides. Their areas are as the square or square root of their bases according as it is in the duplicate or subduplicate ratio.

(7) Similar triangles are to one another as their bases. They are also to each other in the duplicate ratio of their homologous sides.

(8) Triangles are said to be similar when they have their corresponding sides equal and are equal in area. Similar triangles are to one another in the duplicate ratio of their homologous sides.

Each of these exhibits a pleasing variety and a liberal-minded, large-hearted toleration of conflicting views.

Such examples might be multiplied almost indefinitely, and they show clearly the impotence of the dictum "similar triangles are to one another in the duplicate ratio of their homologous sides" to convey any real knowledge to the mind of the ordinary learner. "Duplicate ratio" and "homologous" are mere sounds, to the latter of which violence is often done, inasmuch as I have frequently met with "homolicus" and "harmologous" sides.

Now, as regards the amount of time which is spent in the schools by young boys in acquiring the elementary facts and conceptions of geometry from Euclid's book, I know that very many months are occupied in attaining to the twelfth proposition of the first Book. I have before me, in fact, a fair-sized treatise written for the purpose of guiding boys along Euclid's exact path to this proposition.

There is absolutely nothing in the first twelve propositions that could not be taught far more effectively to a boy of ordinary intelligence in a few days, if only a rational style of teaching geometry were adopted; but if the exact language and pedantic professionalism of the school Euclids must be followed, to the weariness of the boy's mind and the quenching of his interest, it becomes a very long process indeed—ending, in the case of a large number, in utter failure.

Moreover, the current practice which insists on compelling boys to study geometry in an order and language characteristic of mediæval times, when no physical sciences existed, is a hindrance to the study of such sciences now, inasmuch as geometry is one of the foundations of all exact science; and it is obvious that if an intelligent knowledge of geometry is postponed, the physical sciences must be kept back also.

The plea that Euclid's book is unrivalled as an exposition of clear logical method and arrangement, and, as such, must be the foundation on which to build geometry, is vain—for the simple reason that it is not in England (where Euclid is worshipped), but in France and Germany (where Euclid is unknown as a text-book), that the great discoverers in geometry have been produced.

The late M. Paul Bert, Minister of Public Instruction in France, published a little book on the proper method of teaching geometry to beginners, in which he severely satirised the faults of the existing procedure; and, again, the late Rev. W. A. Willock (father of Dr. Sophie Bryant), in his "Elementary Geometry of the Right Line and Circle," has similar excellent remarks on this subject. "It is almost certain," says Dr. Willock, "that Euclid wrote his 'Elements' not for boys, but for grown-up, hard-headed thinking men."

Certain concessions have been made to the advocates of reform, led chiefly by Mr. Hayward—notably by the University of Oxford and the Civil Service Commissioners; and, in the existing state of affairs, it is not reasonable to expect more.

It will be clear from the foregoing that, in my opinion, a more rapid progress in the study of science generally would ensue from any system which would facilitate and accelerate the understanding of geometry by boys in the very elementary stage; and to this end I would suggest that the initiative should be taken by the Universities of Oxford and Cambridge. Our vast system of competitive examinations renders it necessary that a fixed source of authority on the order of deduction in geometry should exist. Such a source is Euclid at present; but a better one might, without serious difficulty, be drawn up by a University Committee, and its adoption by the schools and colleges throughout the country would follow as a matter of course. The chief difficulty is to avoid "fads"; but I learn, from conversation with a distinguished master in the largest of our public schools, that sympathy would not be wanting in an attempt to improve existing methods.

GEORGE M. MINCHIN.

The Cataloguing of Periodical Scientific Literature.

SOME three years ago, I alluded, in a work on "The Theory of Bibliography" (pp. 81–82), to the importance of learned societies undertaking to catalogue the literature they produce.

I pointed out that it was already necessary to supply tables of contents to each journal, bulletin, &c., issued, and that a very slight amount of extra care would transform such tables of contents into technical *Catalogues* of articles, useful alike to the librarian and student—of which extra copies might be struck off at no expense. I referred to the noteworthy efforts of the R. Istituto Lombardo di Scienze e Lettere in registering the articles of foreign scientific journals in its *Bulletin*, and showed the advantages which would accrue if each society *did its own work first*.

I am happy to state that the society referred to has taken my remarks in the spirit in which they were written; and, in publishing vol. xxx. of its *Rendiconti* in 1897, has issued accompanying sheets ("Titoli da ritagliare per le schede dei Cataloghi per Autori e per Oggetti") containing full titles (printed on one side only) of the articles appearing in the volume, under *Author*, *Subject* (and *Place*).

MELZI, GILBERTO.—Sopra alcune rocce dell' isola di Ceylan.
Rend. Ist. Lomb., serie 2, vol. xxx. p. 89. (Milano, 1897.)

CEYLAN.—G. Melzi.—Sopra alcune rocce dell' isola di Ceylan.
Rend. Ist. Lomb., serie 2, vol. xxx. p. 89. (Milano, 1897.)

GEOLOGIA: CEYLAN.—G. Melzi.—Sopra alcune rocce dell' isola di Ceylan.
Rend. Ist. Lomb., serie 2, vol. xxx. p. 89. (Milano, 1897.)

(*It would be advantageous to give the full pagination*, e.g. *pp.* 89-102.—*F. C.*)

The advantages of such a course are obvious.

If each English learned society followed suit, and catalogued its own publications at the moment of issue, it would be only necessary to send the results to a central bureau (say the Royal Society), and the work of cataloguing our scientific periodical literature would be half-finished. There would still remain the task of editing—of sorting, classifying, and of occasional amplification or excision: but such work would be immensely lightened and facilitated if the preliminary actual cataloguing were already accomplished and in print.

This is the first and fundamental principle of co-operation in regard to the literature of the learned societies. Perhaps the Royal Society has already urged its application? If not, may I take this opportunity of drawing attention to the matter?

FRANK CAMPBELL
January 16. (of the Library, British Museum).

Plague in China.

IN the "Encyclopædia Britannica" (ninth edition, vol. xix. p. 168), Dr. J. F. Payne writes: "It is remarkable that of late years reports have come of the occurrence of Oriental plague in China. It has been observed in the province of Yunnan since 1871 . . . it appears to be endemic, though there are rumours of its having been brought from Burmah, and become more noticeable after the suppression of rebellion in that province [1872]." However, the following passage I have lately found in Hung Liang-Kih's "Peh-Kiang-Shi-Hwa" (British Museum copy, 15,316, *a*, tom. iv., fol. 4, *b*), bears witness to the much earlier occurrence of the pest in Yunnan, inasmuch as the author, who was born in 1736, and died in 1809, speaks of his contemporary dead thereby:—"Shi Tau-Nan, the son of Shi Fan, now the Governor of Wang-Kiang, was notorious for his [poetic] gift, and was only thirty-six years old when he died. . . . Then, in Chau-Chau [in Yunnan] it happened that in daytime strange rats appeared in the houses, and lying down on the ground, perished with blood-spitting. There was not a man who escaped the instantaneous death after being infected with the miasma. Tau-Nan composed thereon a poem, entitled "Death of Rats," the masterpiece of his; and a few days after, he himself died from this '*queer rat epidemic*.'"

KUMAGUSU MINAKATA.

7 Effie Road, Walham Green, S.W., February 11.

A SIMPLE SPECTROSCOPE AND ITS TEACHINGS.

I.

SPECTRUM analysis is now becoming so far-reaching, especially in inquiries having to do with the conditions of the various celestial bodies, that there are many who are anxious to know something of its teachings. To some of these, however, the terms used by men of science, a very necessary shorthand, are unfamiliar and appear hard to understand, because the opportunity of seeing the things they are intended to define, and which they generally do define in most admirable fashion, has never presented itself. I propose, therefore, to attempt to show that there is nothing recondite about these terms; that it is possible without any expensive apparatus for every one, who will take a little trouble, to observe the phenomena for himself, after which the meanings of the terms employed will present no difficulty whatever.

One key to the hieroglyphics, the light story, which is hidden in every ray of light, is supplied to us by the rainbow. It teaches us that the white light with which nature bountifully supplies us in the sun's rays, is composed of rays of different kinds or of different colours; and it is common knowledge that there is an almost perfect analogy between these coloured lights and sounds of different pitches.

The blue of the rainbow may be likened to the higher notes of the key-board of a piano, and the red of the rainbow, on the other hand, may be likened to the longer sound waves, which produce the lower notes; and as we are able in the language of music to define each particular note, such as B flat and G sharp, and so on, so light-waves are defined by their colours or wave-lengths.

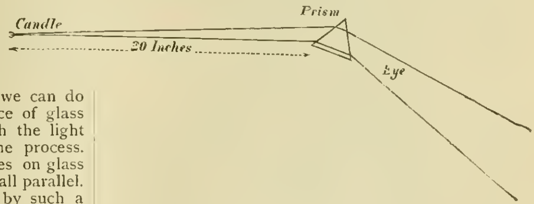


FIG. 1.—Arrangement of candle, prism and eye.

What nature accomplishes by a rain-drop, we can do with a prism or a grating. A prism is a piece of glass or other transparent material through which the light is bent out of its course or *refracted* in the process. A grating is a collection of wires, or scratches on glass or metal; equidistant, very near together and all parallel. When light passes through or is reflected by such a system it is said to be *diffracted*, and one result that we are concerned in, is very similar to that of passing light through a prism.

It is rapidly becoming a familiar fact to many that when a ray of white light is refracted by a prism, or diffracted by a grating, a band of colour similar to a rainbow is produced, and that this effect follows because white light is built up of lights of every colour, each colour having its own special length of wave and degree of refrangibility. Our rainbow band is called a spectrum.

Such a glass prism or grating is the fundamental part of the instrument called the spectroscope, and the most complicated spectroscope which we can imagine, simply utilises the part which the prism or grating plays in breaking up a beam of white light into its constituent parts from the red to the violet. Between these colours we get that string of orange, yellow, green and blue, which we are familiar with in the rainbow.

For sixpence any of us may make for ourselves an instrument which will serve many of the purposes of demonstrating some of the marvellously fertile fields of knowledge which have been recently opened up to us. From an optician we can get a small prism for 6*d.*; get a piece of wood from 20 to 10 inches long (the distance of distinct vision), 1 inch broad and ½ an inch thick. On one end glue a cork 2 inches high; at the other end fasten, by melting the bottom, a stump of a wax candle of such a height that the dark cone above the wick is level with the top of the cork. Then glue the prism on the cork, so that by looking sideways through the prism the coloured image, or spectrum, of the flame of the candle placed at the other end of the piece of wood can be seen.

We get a band ot colour, a spectrum of the candle flame, built up of an infinite number of images of the flame produced by the light rays of every colour. But, so far, the spectrum is impure because the images overlap. We can get rid of this defect by replacing the candle by a needle.

If we now allow the needle to reflect the light of the candle flame, taking care that the direct light from the candle does not fall upon the face of the prism, we then get a much purer band of colour, because now we have an innumerable multitude of images of the thin needle, instead of the broad flame, close together. The needle is the equivalent of the slit of the more complicated spectroscopes used in laboratories.

We can vary this experiment by gumming two pieces of tin-foil with two perfectly straight edges on a piece of glass so that the straight edges are parallel and very near together. In this way we have a slit; this should be fixed close to the candle and between it and the prism.

Now the light of the candle is white, and the preceding experiment tells us that such light gives us a band containing all the colours without any breaks or gaps. We have what is called a *continuous spectrum.*

The Continuous Spectrum.

If we burn a piece of paper, or a match, or ordinary coal-gas, we get a white light identical to that given us by the candle; solids which do not liquefy when made white-hot, and liquids which do not volatilise under the same condition; and some dense gases when heated, do the same.

This effect is produced because there is light of every wave-length to produce an image of the needle (or the slit); these images blend together continuously from one end of the spectrum to the other.

Let us then consider this fact established, namely, that solid or liquid bodies and dense gases, when heated to a vivid incandescence, give a continuous spectrum. Under these circumstances the light to the eye, without the spectroscope, will be white, like that of the candle.

The Length of the Continuous Spectrum varies with Temperature.

If we put a poker in a fire, it becomes red-hot; if we heat a platinum wire by passing a feeble current of electricity along it, it becomes red-hot like the poker.

In both cases examination by means of the prism shows that the red end only of the spectrum is visible. But if the poker or wire be gradually heated more strongly, the yellow, green, and blue rays will successively appear. Finally, when a brilliant white heat has been attained, the whole of the colours of the spectrum will be present.

Hence we learn that if the degree of incandescence be not high, the light will only be red. But, so far as the spectrum goes—and it will expand towards the violet, as the incandescence increases, as before stated—it will be continuous.

The red condition comes from the *absence* of blue

light; the white condition comes from the gradual addition of blue as the temperature increases.

One of the laws formulated by Kirchhoff in the infancy of spectroscopic inquiry has to do with the kind of radiation given out by bodies at different temperatures. The law affirms that the hotter a mass of matter is the further its spectrum extends into the ultra-violet.

Gaslight is redder than the light of an incandescent lamp because the latter is hotter. The carbons in a so-called arc-lamp give out a bluish-white light because they are hotter still.

By similar reasoning from experiment we are bound to consider the bluish-white stars, the white stars, the yellow, red and blood-red stars to indicate a decreasing order of temperature.[1]

We shall not go far wrong in supposing that the star with the most intense continuous radiation in the ultra-violet is the hottest, independently of absorbing conditions, which, in the absence of evidence to the contrary, we must assume to follow the same law in all.

An inquiry into the facts placed at our disposal by stellar photographs, shows that there is a considerable variation in the distance to which the radiation extends in the ultra-violet, and that the stars can be arranged in order of temperature on this basis.

Judged by this criterion alone, some of the hottest stars so far observed are γ Orionis, ζ Orionis, α Virginis, γ Pegasi, η Ursæ Majoris, and λ Tauri. Of stars of lower, but not much lower, temperature than the above, may be named Rigel, ζ Tauri, α Andromedæ, β Persei, α Pegasi, and β Tauri.

In this way spectrum analysis helps us with regard to *temperatures*, both on the earth and in the heavens.

Discontinuous Spectra with Bright Lines.

Let us next pass from a solid which retains its incandescence like platinum wire without melting, or a liquid which retains its incandescence without volatilising, like molten iron, and see what happens. We have found that when the light entering the slit consists of every colour and every tone, we have a *continuous* band of colour. If there be any defect in the light we must have a *discontinuous* one, for the reason that an image of the slit cannot be produced in any particular part of the spectrum if there be no light of that particular colour to produce it when we deal with coloured flames or vapours or gases rendered incandescent by electricity.

There are many artificial flames which are coloured, and if their light be analysed in the same way as the light of the candle, a perfectly new set of phenomena present themselves.

Let us again make use of our improvised spectroscope, and allow the needle to be illuminated by the flame of a spirit lamp into which salt is gradually allowed to fall; we see at once why the flame is orange-coloured. It contains no red, yellow, green, blue, or violet rays, so that we should not represent the spectrum by

V I B G Y O R

as in the case of the candle, but simply by

Y

We see one image of the needle coloured in orange. We have passed from the spectrum of polychromatic light—from white light to coloured light—from light of all wave-lengths to light of one wave-length; from an infinite number of slit images giving a continuous band of every colour, to one image of the slit produced by light of one refrangibility, the colour of the image depending upon the refrangibility. What we shall see in passing from the spectrum of the candle to that of sodium vapour in the spirit lamp is shown in the accompanying woodcut.

That we are truly dealing with an image of the needle (or a slit) can be proved by using a slit of any shape. This can be shown by slightly altering our needle experiment. Take a piece of glass and a piece of tin-foil $1\frac{1}{2}$ inches square, cut out of the centre of the tin-foil a disc slightly larger than a threepenny-piece, and gum the remainder on the glass. In the centre, where the disc has been cut away, gum a threepenny-piece. The interval between the threepenny-piece and the tin-foil constitutes a circular slit. Let it replace the needle, and examine the flame of the spirit lamp charged with salt through it with the prism as before.

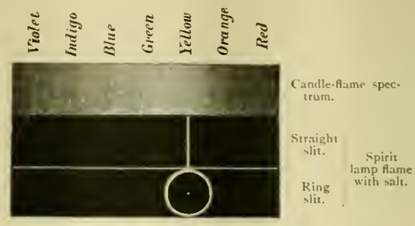


FIG. 2.—A continuous and a discontinuous spectrum.

It will readily be grasped, from what has been stated, that in the case of coloured flames, the light passing through the spectroscope being only red, or yellow, or green, as the case may be, will go to build up an image of the slit in the appropriate part of the spectrum, and that the image thus built up will take the form of a line or circle, according to the slit we use.

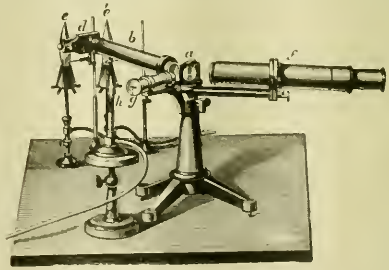


FIG. 3.—Observation of flame spectrum with ordinary spectroscope with comparison prism. *a*, prism; *b*, collimator; *d*, slit; *e e*, flames to be compared; *f*, observing telescope; *g*, scale illuminated by *h* and reflected by the second surface of the prism into the telescope.

Many chemical substances, salts or various metals, become luminous by inserting them into flames, as we have treated common salt (chloride of sodium). With each metal the colour imparted to the flame is different. The resulting spectrum is called a *discontinuous* spectrum, because it is only here and there that images of the slit are produced; because some coloured rays, and not all, are present.

[1] On this point I wrote as follows in 1892: "An erroneous idea with regard to the indications of the temperature of the stars has been held by those who have not considered the matter specially. It has been imagined that the presence of the series of hydrogen lines in the ultra-violet was of itself sufficient evidence of a very high temperature. The experiments of Cornu, however, have shown that the complete series of lines can be seen with an ordinary spark without jar. Hence the high temperature of such a star as Sirius is not indicated by the fact that its spectrum shows the whole series of hydrogen lines, *but by the fact that there is bright continuous radiation far in the ultra-violet.*"

The usual laboratory arrangement for observing the spectra of flames is shown in the woodcuts.

Further, the system of images of the needle (or slit)

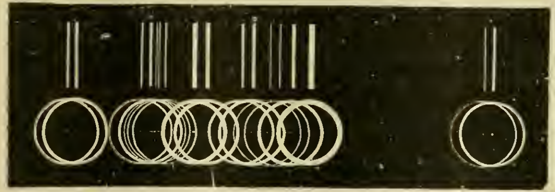


FIG. 4.—The spectrum of a complicated light-source as seen with a circular and a line slit.

varies for each substance, and it is on this ground that the term *spectrum analysis* is used, because we can in this way recognise the various substances in the flame.

But we are not limited to flame temperatures; substances in a state of gas or vapour may be made to glow by electricity. At these higher temperatures very complicated spectra are produced, and again the spectrum is special to each chemical substance experimented on; the images of the needle (or slit), occupying different positions along the spectrum according to the nature of the source of light.

Fig. 3 gives us a laboratory prism spectroscope of small dispersion; with the more complicated spectra the phenomena are often better seen if more than one prism are employed. Fig. 5 shows an instrument in which four prisms are used.

For accurate measures of the wave-lengths of the lines a grating is employed as shown in Fig 6.

It is in the case of the more complicated spectra that the wave-length has to be specially considered from the point of view of defining the position of a line. It is not enough to say, as was said in the case of the sodium line, that it is located in the orange.

The lengths of the various light-waves are very small. The wave-length of the sound-wave of the middle C of a piano is about 4 feet, while the wave-length of yellow light as defined by that of a line very accurately measured

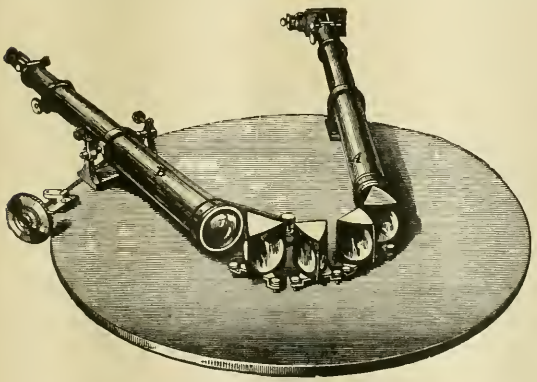


FIG. 5.—Steinheil spectroscope with four prisms.

is ·0005895 of a millimetre, that is 5895 ten-millionths of a millimetre; so that there are 43,130 waves in a British inch. The unit of wave-length usually employed is the ten-millionth of a millimetre. These wave-lengths get shorter as we pass from the red to the violet.

So much then in general for the radiations given out by light sources, and the manner in which the spectroscope shows them, and the student records their positions.

Spectrum analysis was established when experiment proved that no two substances which give a line spectrum give the same order of lines from one end of the spectrum to the other; in other words, the line spectrum of each chemical substance differs from that given by any other.

Here then is one of the secrets of the new power of investigation of which the spectroscope has put us in possession: we can recognise each element by its spectrum, whether that spectrum is

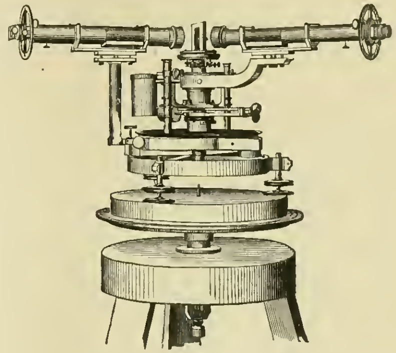


FIG. 6.—Angström's grating spectrometer.

produced in the laboratory or is given by light travelling earthwards from the most distant star, *provided the element exists both here and there.*

It is in this way that spectrum analysis helps us with regard to chemistry; the spectrum varies according to the chemical substance which produces it.

Flutings.

The earliest spectroscopic observations revealed the fact that in some spectra the lines, instead of being irregularly distributed along the spectrum, were arranged in an easily seen rhythmic fashion. Such allocations of lines are called flutings, as a succession of them gives rise to an appearance strongly recalling the flutings of a Corinthian column seen under a strong side light.

Our improvised spectroscope helps us here too; use the candle and straight slit in front of it as before, but shorten the slit, and only allow the blue light from the base of the candle flame to pass through it to the prism. We see two or three sets of flutings. These are the flutings of carbon, and they are amongst the most beautiful examples known and are thoroughly typical.

NORMAN LOCKYER.

(*To be continued.*)

THOMAS HINCKS, F.R.S.

It is little more than a month since an obituary notice of George James Allman appeared in these pages, and death has now claimed another distinguished worker in the same field. The Rev. Thomas Hincks, who died at Clifton on January 25, was but six years younger than Allman, having been born at Exeter on July 15, 1818. Allman's best-known works are his monographs on Gymnoblastic Hydroids and Fresh-water Polyzoa. Hincks' monographs on the same subjects, "A History of the British Hydroid Zoophytes" (1868) and "A History of the British Marine Polyzoa" (1880) are, by an unusual coincidence, more widely known and appreciated than any of his other works. The former was published while the sheets of the "Gymnoblastic Hydroids" were passing through the press, and Allman's opinion of it, recorded in his preface, may fitly be quoted here:—"Eminently critical, with the descriptions accurate and lucid, and with the figures abundant and expressive, it is the most complete systematic work on the Hydroida hitherto published. The large amount of original observations gives it a special value, and its fulness of description and illustration renders it indispensable to every student of the Hydroida."

The praise bestowed on the "Hydroid Zoophytes" must be accorded in the fullest measure to the "Marine Polyzoa." This work constitutes a new departure, containing as it does an account so accurate and critical of the British Polyzoa as to have influenced all later work on this group of animals, and to have made it the best general monograph on the marine Polyzoa which exists in any language.

Hincks' monographs are the ripe results of independent and accurate observation, ranging over the whole area of the subject treated. He was accustomed to take a broad and comprehensive view of his subject-matter; and the classification of the marine Polyzoa in particular owes not a little to his insight. The selection of characters by which to discriminate genera and families was a subject to which he gave special attention; and he was a successful advocate of the view that the surest test of affinities in the Polyzoa is the character of the individual or zoœcium rather than that of the entire colony. The encrusting Cheilostomes formerly known as *Lepralia*, and the erect bilaminate species formerly referred to the genus *Eschara*, were thus distributed among widely separated genera, whose characters probably rest on a firmer foundation than those recognised by the older naturalists. Questions connected with the natural history of zoophytes always excited Hincks' particular interest; and many curious phenomena shown by the living forms have become familiar as the result of his observations.

Most of Hincks' papers appeared in the *Annals and Magazine of Natural History*, between the years 1851 and 1893. Hydrozoa at first came in for the larger share of his attention, but latterly the Polyzoa claimed almost the whole of it. The series of papers entitled "Contributions towards a General History of the Marine Polyzoa" were republished in a collected form in 1894; and one of Mr. Hincks' last pieces of work was the preparation of an index to this series, containing many important additions, which appeared in 1895. This volume is a most valuable record of systematic work, carried out in an admirable manner. The publication of papers on systematic zoology may be of very doubtful benefit in unskilful hands; but of Mr. Hincks' work it can only be said that he enlightened all that he touched. Difficult questions were treated as by the hand of a master, and his wide knowledge and logical faculty led him to conclusions which in most cases command assent.

Thomas Hincks was the son of the late Rev. William Hincks, formerly professor of natural history at Toronto, grandson of the late Dr. Thomas Dix Hincks, professor of Hebrew at Belfast, and nephew of the late Sir Francis Hincks, a distinguished Canadian statesman, at one time governor of Barbadoes, and of the late Dr. E. Hincks, the well-known Egyptologist. He was educated at Manchester New College, York, taking the degree of B.A. at London in 1840, and became minister of the Mill Hill Chapel at Leeds in 1855, resigning in 1869 in consequence of the failure of his voice. He afterwards lived at Taunton, and subsequently for many years at Clifton, where he died.

Mr. Hincks' name appears in the list of those who attended the seventh meeting of the British Association at Liverpool in 1837. He took an active part, at the earliest stage, in the preparations for the recent meeting of the Association at Bristol; but failing health unfortunately prevented him from taking any share in its proceedings last September. He was of active habits, devoted to open-air labour in his garden until comparatively near the close of his life, and it was probably owing to this that he was able to continue his scientific work until a year or two ago. He was a man of singular refinement and dignity, a correct and convincing speaker, and was distinguished for the zeal with which he threw himself into all charitable and philanthropic work at Leeds, in spite of the heavy and exhausting scientific work which he undertook at a time occupied by absorbing pastoral claims. He was a conspicuous example of the type of naturalist, common in this country, who earn for themselves distinction during the leisure spared from the performance of other duties. He became a Fellow of the Royal Society in 1872, shortly after leaving Leeds. He married in early life Elizabeth, daughter of Mr. John Allen, of Warrington, who, with two daughters, survives her husband.

Mr. Hincks was the friend of Allman, Busk, and Principal Dawson, as well as of Canon Norman, Prof. McIntosh and Prof. F. A. Smitt, of Stockholm, whose important works on the Polyzoa, published in Swedish, he did so much to make known to English naturalists.

The writer of these lines is indebted to Mr. W. A. Shenstone for most of the personal details, but he is able to add his own grateful testimony to the kindness and courtesy shown by Mr. Hincks in his correspondence with those who applied to him for information.

The study of zoophytology is the poorer by the loss of one whose work will endure. S. F. H.

NOTES.

Sir William MacCormac, President of the Royal College of Surgeons of England, delivered the Hunterian Oration on Tuesday afternoon in the theatre of the college in the presence of the Prince of Wales and a large and distinguished company. He rapidly reviewed the events of Hunter's life, enumerated his chief contributions to biological and surgical science, described his methods in research and in instruction, and paid a warm tribute to the astonishing range of his investigations, the magnitude of his actual achievement, and the far-reaching influence he had exercised on the subsequent development of surgery. In the course of his address, the *Times* reports him to have remarked: "In the first instance Hunter's work was biological, his range including both the animal and vegetable kingdoms, and the mineral kingdom as well, and to illustrate his investigations he became a collector. But he was chiefly and finally a surgeon, and to the development of surgery he brought all the knowledge and all the training which he had acquired in other branches of science. He carries us beyond mere handicraft and detail into the region of general principles and law. The surgery of the Middle Ages was a trade, Ambroise Paré and Jean Louis Petit converted it into an art, John Hunter elevated it to the rank of a science. Hunter's life and work in-

spired his successors with the spirit of observation, investigation, and experiment. We see this exemplified in his great followers Cline, Abernethy, Astley Cooper, Travers, Green, Brodie, Lawrence, and others since their time. They have been makers of English surgery, and each in turn has done much to raise it to that high standard which it has always maintained."

It is interesting to learn that "it is not the intention of the Government to move the Geological Museum from Jermyn Street." This is the reply (reported in the *Standard* of February 10) which was given by the Right Hon. A. Akers-Douglas to a question asked in the House of Commons by Sir F. Powell. Those who are accustomed to make practical and scientific use of the Geological Survey and of the Museum in Jermyn Street, will hail this decision with satisfaction.

In the House of Commons, on Thursday last, Mr. Akers-Douglas announced that it is proposed to commence the new buildings in front of the South Kensington Museum within the next few weeks. He said that all the new buildings on the east side of the Exhibition Road will be devoted to the art collections. The existing science building on the east side of the road will be the only portion which will continue to be used for science purposes. The new science buildings will be erected on the west side of the road.

In reply to a question referring to the Imperial Institute, asked in the House of Commons on Tuesday, Mr. Chamberlain said: "I believe that a conference of representatives of the Government, the Imperial Institute, and the London University will shortly take place to consider whether a part of the Institute buildings can, with due regard to all existing interests, be made available for the accommodation of the London University, as reconstituted by the Act of last Session. Until the result of the deliberations of the conference is known it would be premature to consider what, if any, further steps should be taken in the matter."

Mr. W. H. Preece, C.B., F.R.S., having on Wednesday attained his sixty-fifth birthday, retires from the position of Engineer-in-Chief and Electrician to the Post Office, but it is hoped that his services will be retained by the Postmaster-General as consulting engineer.

At the anniversary meeting of the Royal Astronomical Society on Friday last, Mr. Frank McClean, F.R.S., was awarded the gold medal of the Society for his photographic survey of stars in both hemispheres, and other contributions to the advancement of astronomy.

The Board of Agriculture have appointed a departmental committee to inquire into and report upon the working of the Diseases of Animals Acts in so far as they relate to glanders, and to consider whether any more effective measures can with advantage be taken to prevent the spread of that disease.

On Friday last Mr. W. W. Skeat, of Cambridge University, left England upon a scientific expedition to the southern portion of Siam lying immediately to the north of the Protected States of the Malay Peninsula. Mr. Skeat is accompanied by two zoologists—Messrs. Evans and Annandale, of Oxford—and by Mr. Gwynne-Vaughan, formerly of Christ's College, Cambridge, as botanist. Later on several other scientific members are to join the party. The expedition will investigate the fauna and flora of the region mentioned, as well as the ethnology of its inhabitants, and it is expected will last about a year.

Dr. D. T. MacDougal, of the Botanical Department of the University of Minnesota, has been elected director of the laboratories of the New York Botanical Gardens, and will begin his duties in that institution upon the completion of the museum and laboratory building in July. The main horticultural houses of the garden, covering nearly three acres, are now in process of construction, and will be ready for use during the current year.

A report from Krasnoyarsk states that the remains of a balloon, and the bodies of three men, have been found between Komo and Pit, in the province of Yeniseisk, by two Tunguses, a tribe inhabiting the Taimur peninsula, in northern Siberia. It is suggested that the dead men are Herr Andrée and his companions, but the information so far received is not sufficient to justify any conclusion being arrived at. The latest news is from Stockholm, and it reports that a telegram has been received there from M. Reuterskiöld, the Swedish Minister in St. Petersburg, in which he states that he has to hand a telegram from the Governor-General of Eastern Siberia confirming the statements of the two Tunguses. The Governor adds that he has despatched a mining inspector to conduct investigations on the spot.

The Department of Science and Art informs us that a horticultural congress will be held at Ghent in June next.

The twenty-ninth general meeting of the Institution of Mining Engineers will be held in North Staffordshire on Wednesday, February 22.

The death is announced of Dr. Dareste de la Chavanne, distinguished by his investigations in animal teratology, and formerly president of the French Society of Anthropology.

We regret to see the announcement of the death of the Rev. William Colenso, F.R.S., of New Zealand. He was distinguished as a naturalist, and made many valuable investigations of Maori antiquities and myths.

The *Athenaeum* announces the death of the well-known zoologist and geologist, Dr. Franz Lang, of Soleure, at the age of seventy-eight. He was for many years teacher of natural history at, and rector of, the Kantonal-Schule, and also one of the presidents of the Swiss Naturforschende Gesellschaft.

Mr. A. A. Campbell Swinton will give a lecture on "Electric Discharges in Vacuo, and the Röntgen Rays," at the Glasgow Philosophical Society, on March 1.

We learn from the *Lancet* that the Cameron prize of the University of Edinburgh, which is conferred on persons who have made valuable additions to the subject of practical therapeutics, has, on the recommendation of the Faculty of Medicine, been awarded by the Senatus Academicus to Dr. Monckton Copeman, of the Local Government Board, London, in recognition of his researches on the employment of glycerine for destroying pathogenic organisms in vaccine lymph.

The question of the future water-supply of London, which has agitated the minds of many, was dealt with on February 8, at a meeting of the Sanitary Institute, by Mr. R. E. Middleton. He maintained that our magnificent river (the Thames) can afford a more than sufficient supply of water of the best quality, and at far less expense, than the suggested scheme for procuring a supply from Wales. Sir Douglas Galton, who occupied the chair at this meeting, said it had been abundantly shown that the filtration of water, as practised in London, gave us a most admirable supply at the present time. Major Flower remarked that the Staines Reservoir, now in course of construction, would, when completed, meet all requirements, and obviate the necessity of going to a distant source for the supply of water.

We learn from the *British Medical Journal* that, on February 2, a new Bacteriological Institute was formally opened in the University of Louvain. The Institute is on a large scale, and

the installation and equipment are in accordance with the most advanced ideas. Every facility for research is provided. The stables, kennels, and other quarters for animals are built around a vast garden, and all the arrangements show careful regard for the health and comfort of the animals. A special department in the new Institute will be devoted to the preparation of therapeutic serums of different kinds, tuberculin, &c. At the congress on tuberculosis, held in Paris last summer, Prof. Denys gave an account of a new tuberculin which he had used with considerable success; he proposes to continue his work in this field, and is hopeful of success.

THE consent of the Privy Council has been obtained for the regulations as to the keeping, dispensing, and selling of poisons adopted by the Pharmaceutical Society on January 11. By the adoption of these regulations, it becomes unlawful for any person who is not a pharmaceutical chemist, or a chemist and druggist within the meaning of the Pharmacy Act, to retail, dispense, or compound poisons for the public. Bottles or boxes, or other vessels containing poisons, have all to be labelled, and have some distinctive mark to call attention to the dangerous character of the contents. Also in the keeping of poisons, each poison must be kept on one or other of the following systems, viz.: (*a*) In a bottle or vessel tied over, capped, locked, or otherwise secured in a manner different from that in which bottles or vessels containing ordinary articles are secured in the same warehouse, shop, or dispensary; or (*b*) in a bottle or vessel rendered distinguishable by touch from the bottles or vessels in which ordinary articles are kept in the same warehouse, shop, or dispensary; or (*c*) in a bottle, vessel, box, or package kept in a room or cupboard set apart for dangerous articles. Similar precautions have to be taken as regards the bottles or boxes in which poisons are sold or dispensed.

A CORRESPONDENT has called our attention to a statement which has appeared in various newspapers as to a peculiar characteristic of Mr. Gladstone's eyes. There is no doubt that Mr. Gladstone had striking and powerful eyes, but, according to the statement referred to, he also possessed nictitating membranes, which he occasionally used to paralyse his opponents in argument. We have asked the opinion of a distinguished authority upon the story, and he expresses the conviction that it is "all nonsense." He adds: "The nictitating membrane is not present, either in human eyes or in those of apes, except as a rudimentary crescentic fold at the inner corner, too small to cover the eye; and the muscles which, in birds and some mammalia, cause the membrane to advance, are wholly wanting in men and apes. In birds the whole mechanism is very elaborate: in mammalia it is comparatively simple. If Mr. Gladstone possessed a nictitating membrane, and a power of moving it, he must have thrown back behind the hypothetical "missing link" ancestry of the human race. Moreover, the nictitating membrane, when present, as may be seen in five minutes in any fowl-house, does not cover the eye during waking life, and is not transparent. It is only drawn across the surface momentarily, from time to time, as a means of cleansing it. Mr. Nettleship, who operated on Mr. Gladstone for cataract, would, of course, be able to speak positively as to the suggested malformation."

FROM the beginning of this month the weather over these islands has been of a very abnormal character, the shade temperature culminating in a maximum of about 67° in the neighbourhood of London on the 10th inst.—a reading which was about 5 higher than any shade temperature in February during at least the last sixty years. In connection with this abnormal temperature a series of gales has swept the country from end to end, in such rapid sequence that the seas have been lashed into fury on most of our coasts, and much damage has been caused by floods in various localities. The rainfall has also been very considerable, especially in the northern and western parts of the country.

AT the Royal Geographical Society on Monday, Prof. Norman Collie, F.R.S., gave an account of two journeys taken during 1897 and 1898 through that part of the Canadian Rockies that lies between the Kicking Horse Pass on the south and the source of the Athabasca River on the north. The most interesting problem connected with the first journey which presented itself to Prof. Collie and his party was whether a lofty mountain seen from the slopes of Mount Freshfield, from which it lay distant about thirty miles in a north-westerly direction, might be Mount Brown or Mount Hooker, which were supposed to be 16,000 feet and 15,000 feet high respectively. For nearly seventy years these peaks had been shown in maps as the highest points in the Rocky Mountains, but it appears that they are not so distinguished. The peak climbed by Douglas, and said to be 17,080 feet high, turns out to be more probably the Mount Brown of Prof. Coleman, having a height of 9000 feet. Prof. Collie's journeys lead him to the conclusion that there is only one Athabasca Pass, and on each side of its summit may be found a peak—Mount Brown, 9000 feet high, on the north—the higher of the two—and Mount Hooker on the south. Between them lies a small tarn, 20 feet in diameter—the Committee's Punch-bowl. The peaks to the south, amongst which the party wandered last August, were new, and they probably constituted the highest point of the Canadian Rocky Mountain system.

THE new form of electric lamp, invented by Prof. Walter Nernst, of the University of Göttingen, and briefly described in these columns several weeks ago (p. 132), was exhibited and explained by Mr. James Swinburne at the Society of Arts on Wednesday in last week. The part of the lamp which emits the light consists a of a little rod of highly refractory material, mainly thoria, supported between two platinum electrodes. Such a substance at ordinary temperatures is a non-conductor of electricity, but when heated it becomes an electrolyte, and it is upon this difference that the action of the lamp depends. When the lamp is required for use, it is first gently heated—with the smaller sizes an ordinary match suffices—until it begins to conduct; the current then passes and further heats the rod until it attains a temperature of intense incandescence and gives out a brilliant white light. In some circumstances this method of starting the lamp might not be regarded as a very great inconvenience; in others it certainly would. Prof. Nernst has, therefore, designed an automatic lamp, lighted simply by turning a switch, in which the required heating of the rod is effected by means of a platinum resistance arranged close to it, which is automatically cut out as soon as the rod becomes hot enough to conduct. The life of the rods used, running at an efficiency of $\frac{2}{3}$ of a candle-power per watt, including the resistance, is more than 500 hours in good specimens. The lamp works equally well on alternating and direct currents, and does not need to be enclosed in a vacuum.

WORKMEN who work in compressed air are sometimes the victims of a peculiar malady which has been designated caisson disease or compressed air disease. Dr. Thomas Oliver has made observations of several cases of this kind of illness, and he comes to the conclusion that the symptoms are best explained by the theory that the malady is due to increased solution, by the blood, of the gases met with in the compressed air, and the liberation of these gases during decompression. The increased solution of the gases is, of course, due to the greater pressure upon the person of the caisson worker.

In one of the last numbers of the U.S. *Monthly Weather Review* (October 1898), Mr. H. Earlscliffe makes a suggestion of the possible utilisation of fog, which should call forth all the inventive genius of America. He states that in California there are vast areas of valuable land where the water supply is insufficient, but which are frequented by heavy fogs from the ocean. These fogs generally occur at night during the dry summer months, when moisture is most needed, and are dissipated early in the morning by the sun. Neither science nor art can at present suggest any feasible method of condensing the moisture, and causing the fog to descend in drops of rain. What is needed is some simple mechanical arrangement by which the fog particles shall be intercepted and forced to drip or glide downward to the ground, or to catch them as the leaves of the trees do. Such devices as the explosion of dynamite are likely to be too expensive in comparison with the return they make.

In *Ciel et Terre* of the 1st inst. there is an article by M. Lancaster, Director of the Meteorological Division of the Brussels Observatory, entitled "Frost and Anti-cyclones." At a recent meeting of the Royal Meteorological Society, Mr. W. H. Dines read a paper on the winter temperature and height of the barometer in north-west Europe, in which he stated that the winter temperature did not depend upon the height of the barometer, and that it was just as likely to be cold when the barometer is below the average as when it is above the average. M. Lancaster draws attention to his paper in *Ciel et Terre* in 1895, in which he comes to nearly the same conclusion as Mr. Dines; and he states that the tables of monthly mean barometric pressures for Brussels from 1833 to 1898 show that during the seven months of December, which gave the highest mean barometric values, only one, that of 1879, had a temperature below the average. In ten months of January, with exceptionally high barometric pressure, the temperature, however, was below the average; while out of eight months of February, with high pressures, only one (1887) had a temperature below the average. The careful scientific work of both authors is beyond question; it may be mentioned, however, that Mr. Dines' paper met with considerable criticism, and, unless meteorological text-books are to be rewritten, the matter calls for further careful inquiry, with the view of seeing that no fallacy underlies the investigation.

In the *Revue scientifique* of January 7, we learn that on October 31 a small monument was erected at the small village of Saint-Lothaire in the Jura, to Charles Marc Sauria, the original inventor of matches. The writer of the paper, Dr. Cabanès, tells us that Sauria was born in 1812, and was the son of General Sauria. He always showed a keen interest in scientific inventions of all kinds, and while studying for the medical profession at the college at Dôle, obtained some chemicals from an apothecary, and spent all his spare time in trying to make a match which would light by striking, while his fellow students were enjoying themselves. In the winter of 1830–31 his efforts were crowned with success. Sauria confided his inventions to his professor, M. Nicolet. Sauria gained but little profit from his invention, which he could not afford to patent, and spent the greater part of his days as a simple country doctor. It is interesting to learn that matches were invented independently in 1832 by Frederic Kammerer, an Austrian, who seems to have died in great poverty; and the same discovery is also attributed to the Hungarian Irinyi.

We have received a reprint of a paper, published by Prof. Edward S. Morse in the November number of *Appleton's Popular Scientific Monthly*, entitled "Was Middle America peopled from Asia?" Prof. Morse answers the question in the negative, reviewing the arguments of the Asiaticists, and supports his conclusions by pointing out the absence of any evidence of interchange of social commodities.

An important paper on physiographical problems raised by the distribution of temperature and salinity in the waters of the northern Pacific, is contained in *Petermann's Mitteilungen* for January. The discussion is chiefly based on the work of the U.S. s. *Albatross* between 1890 and 1895, and of the Russian vessel *Vitiaz*, under Makarow, in 1887. Considerable light is thrown on the movements of the deeper waters in the Bering and Okhotsk Seas, and in the western and central Pacific generally.

Petermann's Mitteilungen gives an account of the work of the international Glacier Commission appointed by the Geological Congress at Zürich in 1894. The Commission has issued a preliminary discourse by Prof. F. A. Forel, and three annual reports. The result of widest general interest arrived at, so far, is that periodic variations of climate are much more marked in the central regions of continents than on the borders. Coast-lands, and especially those of the Atlantic, are exceptional regions, in which characteristic dry periods are not, in general, recognisable. The advance and retreat of glaciers show corresponding differences.

We have received the second number of *La Cultura Geografica*, a new illustrated review, published twice a month at Florence. It is to contain short articles on all branches of geography, but special attention will be paid to the geography of Italy, terrestrial physics, anthropogeography, and the history and teaching of geography. Among the subjects treated in the last issue are Danubian Italy, the poles of low temperature, the vertical distribution and grouping of the lakes of the province of Trent, &c.

The volume of *Proceedings* of the Indiana Academy of Science, recently published, contains the results of a statistical inquiry into the variations of two species of Etheostoma living in lakes in the State. The paper is a contribution from the zoological laboratory of the Indiana University, the director of which, Prof. C. H. Eigenmann, explains that for the purpose of making a detailed comparison between the faunas of two units of environment, a biological station has been established on Turkey Lake, Kosciusko County, Indiana. Five miles from this lake is another lake of different shape and depth—Tippecanoe Lake. The two lakes are on opposite sides of the watershed separating the St. Lawrence from the Mississippi Basin. A physical survey has been made of these lakes, and the physical and biological conditions of the two lakes are being studied as two units of environment within which it is proposed to determine the extent of variation in the non-migratory vertebrates, the kind of variation, whether continuous or discontinuous, the quantitative variation, the direction of variation, and the annual or periodic variation and the effect of selection.

A paper by Mr. W. J. Moenkhaus, on the variation of specimens of *Etheostoma caprodes* and *E. nigrum* in two lakes, is one of a series projected to illustrate the points referred to in the foregoing note. The chief results are summarised as follows: (1) In *Etheostoma caprodes* the males are more variable than the females in the ratio of ·507 : ·468. In *Etheostoma nigrum* the females are more variable than the males in the ratio of ·402 : ·454. (2) The specimens of both species in Turkey Lake differ from those in Tippecanoe Lake in every structure examined. (3) The variation in the two species is determinate for the lake—that is, both species are modified in the same way by the same lake with but one exception. (4) This difference is not the

result of selective influence, but apparently the direct effect of the environment.

A RECENT number of the *Bulletin de la Société de Géographie* contains a paper by M. Edouard de Sainville on his sojourn on the lower course of the Mackenzie River between 1889 and 1894. A descriptive account of the region and its Indian and Eskimo inhabitants is given in some detail. Amongst other observations of interest, M. de Sainville notes the entire absence of phthisis among the natives, and the occurrence of colds only on contact with civilisation. The experiment was tried of opening a soldered zinc case from Winnipeg in a perfectly healthy camp, and distributing the contents; next day every member developed a violent cold, which was cured by the administration of camphor.

Bulletin No. 162 of the Michigan State Agricultural College Experiment Station is devoted entirely to the subject of forestry, one of very great practical importance to the State.

THE *Bulletin* of the Illinois State Laboratory of Natural History publishes a list, by Mr. Adolph Hempel, of the Protozoa and Rotifera found in the Illinois river and adjacent lakes at Havana, Ill. In the Protozoa are included *Volvox* and other allied forms. We have received also the Biennial Report, by the director of the same State Laboratory.

IN view of the encouragement of new industries in the tropical possessions lately acquired by the United States, the U.S. Department of Agriculture (Division of Botany) has issued, in the form of *Bulletin* No. 21, an account, by Mr. S. J. Galbraith, of the culture of Vanilla, as practised in the Seychelles Islands.

IN an article in the *Journal* of the Royal Horticultural Society for January, on the "Origin of Species-inducing Varieties," the Rev. G. Henslow states his conviction that it is not a rich soil which first induces doubling in plants, but a poor one; but, let the doubling be once thoroughly set up in the plant's constitution, and it then seems that a rich soil will probably enhance it. We have received also, from the Royal Horticultural Society, a very full programme of arrangements for the year 1899.

THE December (1898) issue of *Himmel und Erde* contains an interesting article, by Herr G. A. L. Runker, on the photography of lightning, which is illustrated by a beautiful reproduction from a photograph of "ribbon" lightning obtained at the Hamburg Observatory. Dr. F. Koerber continues his article on spectrum analysis, treating of the spectra of the planets and their satellites.

THE *Verhandlungen* of the German Zoological Society, containing reports, papers, and other communications presented to the eighth annual meeting held at Heidelberg last June, have been published by Mr. W. Engelmann, under the editorship of Prof. Dr. J. W. Spengel.

MR. J. A. HARVIE BROWN has sent us a copy of his paper, read at the International Congress of Zoology last August, on "a correct colour code, or sortation code in colours, to serve for mapping the zoo-geographical regions and subregions of the world, and also to be of use as an eye-index for librarians." Accompanying the paper are specimens of colours which it is suggested should be used for book shelves or bindings to indicate, in accordance with the proposed code, the regions to which the works refer.

PROF. H. OSBORN has just published a useful pamphlet on the "Hessian Fly (*Cecidomyia destructor*, Say) in the United States," forming *Bulletin* No. 16, new series, of the U.S. Department of Agriculture, Division of Entomology. It is accompanied by a map of the distribution of the insect in the States, and several illustrations of its various stages, parasites, &c. Its original habitat is unknown, but it is now found in most countries of Europe, being specially abundant and destructive towards the eastern parts; in the north and west (including England) it is rarely destructive, and appears to have been either overlooked, or to be of recent introduction. In the States, it first attracted attention in Long Island in the year 1778, and was supposed to have been introduced, a year or two before, with fodder or bedding with the Hessian troops, whence its popular name; and this belief Prof. Osborn considers to be not improbably correct. From Long Island the insect extended its ravages in all directions at the rate of about twenty miles per year, and, as shown by the map, it has now invaded the whole of the eastern half of the States, except the south-eastern and the extreme southern States; and has likewise been found in California, about San Francisco. Outside Europe and the States it has been found near Wellington, New Zealand, in 1888, only two years after its presence in England had been verified by entomologists.

THERE are other wheat midgets besides the Hessian Fly, but the characteristic symptom of the attacks of the latter is the breaking down of the stalk, owing to its being weakened by the grub domiciled within. If the stubble, chaff, &c., is burned, or the field deeply ploughed over as early as possible, future injury may be much minimised, if not altogether prevented. The fly chiefly attacks wheat, rye, and barley, but has occasionally been found on grasses. Its abundance, or otherwise, depends much on climatic conditions, and is liable to be reduced by numerous parasites, chiefly small *Hymenoptera*. These, as well as the life-history of the insect, are fully discussed in the pamphlet referred to in the present note, which also includes a full account of the various remedies which have been suggested for its attacks, and a bibliography.

THE additions to the Zoological Society's Gardens during the past week include a Guinea Baboon (*Cynocephalus sphinx*, ♀) from Africa, presented by Mrs. Mellin; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. Hamilton Baker; two Night Herons (*Nycticorax griseus*), European, presented by Mr. Chas. Humberset; a Woodcock (*Scolopax rusticula*), European, presented by Captain Bewicke; two Black-necked Lizards (*Agama atricollis*) from Natal, presented by Mr. W. Champion; a Bennett's Wallaby (*Macropus bennetti*) from Tasmania, an Australian Cassowary (*Casuarius australis*) from Australia, a Two-wattled Cassowary (*Casuarius bicarunculatus*) from the Aroo Islands, a Bennett's Cassowary (*Casuarius bennetti*) from New Britain, deposited; a Brush-tailed Kangaroo (*Petrogale penicillata*, ♀) from New South Wales, a Blue-crowned Parrakeet (*Tanygnathus luzonensis*) from the Philippines, four Bearded Titmice (*Panurus biarmicus*, 2 ♂, 2 ♀), European; two Long-tailed Grass Finches (*Poephila acuticauda*, ♂ ♀) from North-west Australia, a Hobby (*Falco subbuteo*) British, purchased.

OUR ASTRONOMICAL COLUMN.

WOLF'S COMET, 1898 IV.—A. Thraen gives, in the *Astronomische Nachrichten*, an ephemeris for observation of this comet (Bd. 148, No. 3544).

Ephemeris for Berlin Midnight.

1899.	α. h. m. s.	δ.	Br.
Feb. 10	0 13 48	−10 30·0	0·80
20	14 30	9 55·2	·74
24	15 53	9 11·6	·69
28	17 28	8 28·0	·64
Mar. 4	19 24	7 47·3	·59
8	21 30	7 0·9	·55
12	24 11	6 27·0	·51
16	27 0	5 50·5	·47
20	0 30 4	−5 14·8	0·44

During the period the comet moves in a north-easterly direction, its path lying about midway between the belt of Orion and Sirius. From March 8 to 10 it will be passing near the fourth mag. double star β (11) Monocerotis.

COMET CHASE, 1898 VIII. E. F. Coddington gives, also in *Ast. Nach.*, No. 3544, a revised ephemeris and table of elements for this comet, which he has computed from observations made by him at Mount Hamilton on November 23, December 7 and December 16, 1898.

Elements.

T = 1898, Sept. 20·15344 G.M.T.

$$\left.\begin{aligned} \omega &= 4^\circ\ 37'\ 59''\cdot9 \\ \Omega &= 95\ \ 51\ \ 35\cdot9 \\ i &= 22\ \ 30\ \ 20\cdot3 \end{aligned}\right\} 1899\cdot0$$

$\log q = 0\cdot358892.$

Ephemeris for Greenwich Midnight.

1899.		a. h. m. s.		δ. ° ′ ″		Br.
Feb. 16	...	11 3 0·99	...	+36 47 38·3	...	0·91
20	...	11 0 58·16	...	37 15 10·3	...	·87
24	...	10 58 49·87	...	38 16·7	...	·83
28	...	56 39·81	...	56 47·8	...	·79
Mar. 4	...	54 31·44	...	38 10 40·0	...	·75
8	...	52 28·31	...	19 50·9	..	·71
12	...	50 33·54	...	24 26·6	...	·67
16	...	48 50·19	...	24 32·9	...	·63
20	...	47 20·60	...	20 25·6	...	·59
24	...	46 6·59	...	12 20·8	...	·55
28	...	45 9·42	...	38 0 36·7	...	·51
April 3	...	10 44 16·87	...	+37 36 49·3	...	0·48

Comparison of the elements leads to the orbit being considered almost parabolic, and hence there is no probability of its being identical with that of Comet 1867 I., as has been suggested. The comet is now rapidly receding from the sun and decreasing in brightness. It is moving slowly westwards between the pairs of stars γ, ξ and λ μ Ursæ Majoris.

VARIATION OF SPECTRUM OF ORION NEBULA.—Much has been recently said as to whether the spectrum of this nebula is different in different regions. There seems to be no doubt that in different parts certain lines are intensified or reduced relatively to others, but observers are not yet agreed as to the reality of the difference, many ascribing it to physiological causes. Prof. J. E. Keeler, with the Lick 36-inch refractor, has examined it with reference to this matter (*Ast. Nach.*, No. 3541). Near the star Bond 734 the strongest line was Hβ (F). With the slit on the Huyghenion region, near the trapezium, the strongest line was the chief nebula line (λ 5007), while Hβ and the second nebula line (λ 4959) were about equally bright, but much less intense than the chief line. Still keeping the slit in this region, the vertical aperture of the spectroscope was diminished without altering the resolving power. When the brightness was sufficiently reduced, Hβ and the line λ 4959 disappeared, leaving λ 5007 alone visible. Thus in one part of the nebula Hβ alone was visible, in another λ 5007. This is inexplicable on physiological grounds, and would seem to point to real differences in the composition of the nebula.

LATITUDE DETERMINATION.—In the determination of latitude by Tallcott's method, the apparent mean declination of a pair of stars has to be deduced from observations of the star corrected by constant factors dependent on the position of the stars. To facilitate these reductions H. Kimura, of the Tokyo Observatory, gives formulæ and tables for constructing mean star factors (*Ast. Nach.*, Bd. 148, No. 3541). There are also four special tables of these constants given for the particular latitude $\phi = 39^\circ\ 8'\ 10''$, which is that chosen for a number of stations for the coming international work of determining latitude variation.

LYNN'S "REMARKABLE COMETS."—A new edition—the seventh—of this handy little volume has been published by Mr. Edward Stanford. The periodic comets which may be expected to return this year are stated by Mr. Lynn as follows: Spring—The comet of 1866, connected with November meteors (period, 33¼ years). Summer—Tuttle's comet (period, 13¾ years), Tempel's second periodical comet (period, 5¼ years), and Holme's comet (period, nearly 7 years). Winter—Finlay's comet (period, 6½ years).

THE THEORY OF THE STASSFURT SALT DEPOSITS.

"THE formation of the salt deposits at Stassfurt, Wieliczka, and other places, so far as they are of an oceanic origin, cannot receive a detailed explanation until the conditions of equilibrium affecting the salts dissolved in sea-water have been subjected to a systematic investigation.

"First of all, it must be ascertained what grouping the radicals assume in the solid state; that is to say, what solid substances separate out as sea-water is evaporated. Further experiments will then show us how the composition of sea-water is affected by the presence of the various solids, and whether, and to what degree, changes take place—loss of water of crystallisation, formation of double salts, and kindred phenomena—as the composition of the solution alters, until finally the water is wholly evaporated, and a stable system of solids is left behind."

The comprehensive programme of work thus indicated by Dr. Meyerhoffer in 1895 has been seriously entered upon, and the first instalment of results appears in a recent number of the *Zeitschrift für Physikalische Chemie*, vol. xxvii. p. 75.[1]

The investigation promises to be of great interest and importance, viewed both from the theoretical and practical standpoints. The problem of determining the conditions under which a series of salts have been deposited during the concentration of a dilute solution, is very much more complicated than might at first sight appear, and can only be solved by the application of methods and principles that are of recent discovery. The researches that render the investigation possible have been mainly conducted during the past few years in the laboratory of Prof. van 't Hoff; and those who are acquainted with the admirable "Études sur les equilibres chimiques" (translated into English by Dr. Ewan), and with the later publications of van 't Hoff, will know how ably he has developed the theory of equilibrium as applied to the existence of hydrates and of double salts.

The plan of work, with respect to the Stassfurt deposits, is as follows. The chief dissolved substances in sea-water consist of salts formed from Cl, SO_4, Na, K and Mg; the first problem is, therefore, the complete investigation of the salts and solutions producible from these radicals. Even within these limits the investigation is too complicated; so that, first of all, systems formed by water with the chlorides and sulphates of K and Mg are dealt with. Then the consideration is extended to such systems with the addition of rock salt, and the first part of the investigation is concluded.

In the second part the less soluble and less abundant components of the deposits will be considered. Calcium, in the first instance, will receive attention; and then the compounds of boron, bromine, and iron.

The groups of substances to be dealt with are as follows:—

(1) Group formed from the sulphates and chlorides of K and Mg.
- $MgCl_2$ and its hydrates.
- Sylvine, KCl and K_2SO_4.
- $MgSO_4$ and its hydrates; Carnallite, $MgCl_2$, $KCl.6H_2O$.
- Schönite, $MgSO_4$, $K_2SO_4.6H_2O$, and potassium astrakanite $MgSO_4$, $K_2SO_4.4H_2O$.
- Kainite, $MgSO_4$, $KCl.3H_2O$, and Langbeinite $2MgSO_4$ K_2SO_4.

(2) With the addition of NaCl.
- NaCl and Na_2SO_4 and their hydrates.
- Astrakanite (Blodite), $MgSO_4$, Na_2SO_4, $4H_2O$.
- Glaserite (Penny's salt), $K_3Na\,(SO_4)_2$.

(3) With the addition of Calcium.
- $CaCl_2$ and its hydrates.
- Tachydrite, $CaCl_2.2MgCl_2.12H_2O$.
- Gypsum, $CaSO_4.2H_2O$, Anyhdrite $CaSO_4$, and their double salts, such as Krugite, Glauberite, Polyhalite, Syngenite, Mamannite, &c.

(4) With the addition of Boron, Bromine and Iron.
- Boracite, Stassfurtite.
- Magnesium bromide.
- Potassium ferrochloride, &c.

The first instalment of the research, now published, deals exclusively with the hydrates of magnesium chloride. The

[1] Über Anwendungen der Gleichgewichtslehre auf die Bildung oceanischer Salzablagerungen, mit besonderer Berücksichtigung des Stassfurter Salzlagers. Von J. H. van 't Hoff und W. Meyerhoffer.

limits of existence of the following hydrates within $-33°\cdot6$ C. and 186° C. (the temperature at which water begins to decompose magnesium chloride) have been investigated :—

$MgCl_2.12H_2O$, $MgCl_2.8\alpha H_2O$, $MgCl_2.8\beta H_2O$, $MgCl_2\,6H_2O$, $MgCl_2.4H_2O$, $MgCl_2.2H_2O$.

It is impossible within the limits of this notice to discuss the details of the investigation, but the brief indication here given of the nature and scope of the inquiry may serve to direct attention to a research which is obviously of wide interest.

THE NATURAL HISTORY OF CORDIERITE AND ITS ASSOCIATES.[1]

THE last quarter of the present century has witnessed an extraordinary outburst of petrological activity, due, in a large measure, to the application of precise mineralogical methods to the study of the constituents of rocks. The petrologist, and through him the geologist, owes, therefore, an enormous debt of gratitude to the mineralogist ; at the same time, the benefits have not been wholly one-sided. Mineralogy is becoming something more than a mere catalogue of the crystallographic, chemical and physical characters of museum-specimens, and this is largely due to the influence of petrology. It may end in breaking down the artificial systems of classification which are in vogue, and introducing others more in accordance with genetic principles.

A good illustration of the advantage of studying minerals from the natural history point of view may be obtained by considering some facts relating to the modes of occurrence and origin of corundum, spinelle, sillimanite and cordierite—four minerals which are so frequently found together that they have been called the "faithful companions." Corundum is crystallised alumina (Al_2O_3), true spinelle is an aluminate of magnesia ($MgO.Al_2O_3$), sillimanite is the silicate of alumina ($Al_2O_3.SiO_2$), and cordierite is a silicate of alumina and magnesia ($2MgO.2Al_2O_3.5SiO_2$). The mutual replacing properties of ferrous oxide and magnesia, and of ferric oxide and alumina complicate the composition of the spinelles and cordierite. All the minerals contain alumina, and it is this fact which determines their paragenesis. They occur, usually in combinations of two or more, under the most diverse geological conditions :—

(1) As the constituents of foliated crystalline rocks of more or less doubtful origin.

(2) As the products of contact-metamorphism round plutonic masses.

(3) As the constituents of inclusions in plutonic rocks, dykes, lavas and agglomerates.

(4) As the direct products of the crystallisation of igneous magmas.

(5) As the direct products of the crystallisation of artificial silicate-magmas.

Cordierite-gneisses are found in many parts of the world in association with biotite-gneisses and other foliated crystalline rocks. Various views have been expressed as to their origin. Some petrologists are content to refer them to the Archæan system ; others regard them as due to the contact or thermodynamic metamorphism of ordinary argillaceous sediments ; and others as rocks of mixed origin, containing both igneous and sedimentary material. The last view, as applied to certain members of the group but not to all, derives support from the fact that where cordierite-rocks occur as contact products, they always belong to the inner zone, and sometimes give distinct evidence of the intimate intermixture of igneous and sedimentary material.

Cordierite-rocks, often containing sillimanite and a green spinelle, have been recognised, during the progress of the Geological Survey, at many points in the Southern Highlands of Scotland, in the counties of Aberdeen, Banff, Forfar and Argyle, and quite recently corundum has been detected in some of these ; so that the list of the "faithful companions" is now complete so far as Scotland is concerned. It is doubtful at present whether all the Scottish cordierite-rocks are of the same age and mode of origin. Some are contact-rocks, but others may, for the present at least, be more safely classed with the older crystalline-schists. All are undoubtedly the result of the metamorphism of highly aluminous rocks.

[1] Abstract of the presidential address delivered to the Geologists' Association, by J. J. H. Teall, F.R.S., on February [illegible].

A very interesting case of the occurrence of all four minerals in rocks due to contact-action has been described by Salomon. It occurs in the southern part of the Eastern Alps round the great mass of tonalite, of which Monte Adamello forms the culminating point.

Inclusions, derived either from a contact-zone or from the crystalline-schist formation, containing two or more of the minerals in question, have been observed in igneous rocks occurring under the most diverse conditions in many parts of the world. They have been found, for example, in the tonalite of Monte Aviolo ; in the kersantite-dyke of Michaelstein in the Hartz ; in the andesitic lavas of the Eifel, the Siebengebirge and the south-east of Spain ; and, finally, amongst the ejected blocks of the Laacher See and Asama Yama in Japan. There is evidence, moreover, that in most of these cases the minerals, or some of them, occur not only as constituents of the inclusions, but also as the direct products of crystallisation from the igneous magmas. Thus, in the mica-andesite of Hoyazo (Cabo di Gata) cordierite occurs in two forms : (1) as irregularly bounded grains up to the size of a hazel-nut, and (2) as sharply defined idiomorphic crystals in a glassy base. The former are inclusions ; the latter are crystals which have separated from the magma. Rock-fragments, consisting very largely of a cordierite-gneiss from which the isolated grains of cordierite have been derived, are also very common in this andesite. Osann, who has described this very interesting case, points out that the abundance of indigenous cordierite, coupled with the presence of numerous inclusions of cordierite and cordierite-gneiss, points to the conclusion that portions of the foreign rock have been dissolved, and that a magma of exceptional composition has thus been formed, out of which cordierite has crystallised. Many other cases are known in which the solution of foreign aluminous material has so modified a magma that members of the group under consideration have crystallised out of it. Moreover, it is not necessary that the minerals should be present in the foreign material. It is sufficient that the necessary chemical constituents should be present. Thus a basalt from Köllnitz in Carinthia has involved fragments of an argillaceous rock, and partially dissolved them. The normal basalt is holocrystalline, but in the neighbourhood of the inclusions it becomes glassy, and crystals of spinelle and cordierite, which are absent, both from the basalt and the inclusion, occur. The partial solution of the fragments evidently modified the composition of the basalt, so that it cooled as a glass after cordierite and spinelle had separated out. It is interesting to note, in passing, that the addition of alumina to the basaltic magna has tended to prevent crystallisation. This effect of alumina is well known to glass-makers.

The formation of corundum in an igneous rock as the consequence of the solution of argillaceous material is well illustrated by the case described by Prof. Busz. The mineral occurs round inclusions of clay slate in a felsite from South Brent. Many cases of the presence of corundum in igneous rocks under conditions which prove that it must have crystallised out of the magma, are now well known ; and amongst the most interesting are those recently found in Hastings County, Canada, where the mineral occurs in dykes of syenite. In these, however, there appears to be no evidence that the excess of alumina is due to the solution of argillaceous rocks.

The remarkable synthetic experiments of Dr. Morosewicz give a complete and satisfactory account of the chemical and physical conditions under which corundum, spinelle, sillimanite and cordierite separate out of alumo-silicate magmas ; and, therefore, of many of the natural occurrences above referred to. Alumina is soluble in magmas agreeing in composition with albite, nepheline and anorthite, or with mixtures of these, and crystallises out as corundum on prolonged cooling at high temperatures. If both silica and alumina are present in excess of that necessary to form felspar, sillimanite is formed until the excess of silica is used up, and then the remaining excess of alumina crystallises out as corundum. The presence of magnesia determines the formation of spinelle, or of cordierite, or of both, according to the excess of alumina and silica above that necessary to form felspar with the soda, potash and lime present. All these phenomena may be verified within the range of temperature in a Siemens' furnace, such as that used in glass-works. The minerals obtained are in every way similar, except as regards size, to those which occur in nature.

It thus appears that the "faithful companions" may be formed either by the metamorphism of sedimentary deposits, or

as the result of the crystallisation of igneous magmas of exceptional composition. In many cases, if not in all, the presence of these minerals in igneous rocks is the result of the solution of argillaceous material. It seems fair to conclude, from their general absence from masses of granite and other igneous rocks, that the absorption of argillaceous sediments has not taken place on any large scale. But in drawing this inference caution is necessary because, under plutonic conditions, the presence of water may lead to the formation of micas instead of them. Fused biotite gives rise to spinelle, and fused muscovite to sillimanite and corundum.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. G. Sims Woodhead has been appointed professor of pathology in succession to the late Prof. Kanthack.

The Balfour studentship, of the annual value of 200*l*., for original research in biology, especially animal morphology, has been awarded to Mr. J. Stanley Gardiner, Fellow of Gonville and Caius College, for three years from March 25, 1899. Grants from the Balfour fund of 50*l*. each have been made to Mr. J. S. Budgett, of Trinity College, in aid of his researches on the development of polypterus, and to Mr. L. A. Borradaile, of Selwyn Hostel, in aid of the expenses of his proposed journey in company with Mr. Gardiner, the Balfour student.

DR. H. E. ANNETT has been appointed demonstrator of tropical pathology in the newly-founded school of tropical diseases in Liverpool.

WE are asked to state that the offices of the National Association for the Promotion of Technical and Secondary Education have been removed from 14 Dean's Yard to 10 Queen Anne's Gate, Westminster, S.W.

AT the annual meeting of the shareholders of the Patent Nut and Bolt Company (Limited), held on Monday at Birmingham, it was resolved that the company should contribute 5000*l*. to the fund which is being raised for the establishment of a University in Birmingham.

THE London School Board have strongly protested against the application of the London County Council to the Science and Art Department to be recognised as the organisation responsible for science and art instruction in the County of London. A memorial has been drawn up and presented to the Lord President of the Council, asking him not to assent to the application of the County Council, and giving reasons why the Board should be largely represented upon whatever authority was given control over science and art instruction in London.

A COPY of the address delivered at the recent annual meeting of the Association of Technical Institutions, by Earl Spencer, has been received. In the address, the importance attached to a thorough system of technical instruction in America and Germany is pointed out, and the intimate and necessary relations which exist between technical and secondary education are mentioned. Just as it is difficult to give technical instruction without a foundation of good secondary education, so secondary education is retarded and often completely stopped by the poor education of pupils who come from the primary schools to seek it. Earl Spencer made special reference to this lack of system in educational efforts, and remarked that in order to secure sound and good technical education for the population as a whole, many defects of primary education will need to be remedied.

THE Calendar of the Department of Science and Art has been issued. As in former years, the volume contains a history and general description of the Department, with a summary of the rules, and a list of the science and art schools and classes. The total number of individual students who presented themselves for examination in science subjects of the Department in 1898 was 157,306. The six subjects in which the most students were examined are—mathematics (stages 1, 2, 3), 35,945; physiography, 24,877; inorganic chemistry, 23,966; practical plane and solid geometry, 20,238; machine construction and drawing, 18,073; building construction, 13,653. Of the subjects in which practical examinations were held, the first four are—inorganic chemistry, 15,012; magnetism and electricity, 2550; organic chemistry, 1195; sound, light and heat, 1141.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 26.—"On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks. III. On *Medullosa anglica*, a new Representative of the Cycadofilices." By D. H. Scott, M.A., Ph.D., F.R.S., Hon. Keeper of the Jodrell Laboratory, Royal Gardens, Kew.

The existence of a group of fossil plants, combining in their organisation certain characters of the Ferns and the Cycads, has been recognised, of late years, by several palæobotanists. The convenient name, Cycadofilices, has recently been proposed to designate the group in question, which now includes several, somewhat heterogeneous, genera, among which *Lyginodendron*, *Heterangium*, and *Medullosa* may be mentioned.

No stem of a *Medullosa* has hitherto been recorded from this country, though specimens of *Myeloxylon*, now known to have been the petioles of *Medullosa*, are frequent in the calcareous nodules of the Lower Coal-measures.

The author has recently had the opportunity of investigating several excellent specimens of a new species of *Medullosa* from the Ganister Beds of Lancashire. These fossils are of special interest on several grounds; they are considerably more ancient than any members of the genus previously described, they are the first English specimens recorded, they are preserved in a more complete and perfect form than any others at present known, and lastly, the greater simplicity of their structure causes the essential characters of the genus to stand out with greater clearness than in the more complex species. The specimens were discovered by Mr. G. Wild and Mr. J. Lomax, in material from the Hough Hill Colliery, Stalybridge.

The species, which is very distinct from any form previously described, will be known as *Medullosa anglica*.

The most complete specimen of the stem has a mean diameter of rather more than 7 cm., including the adherent leaf-bases, which, to judge from the most perfect specimens, almost completely clothed the surface of the stem. The arrangement of the leaves was a spiral one, and in the only case where the phyllotaxis could be determined, the divergence proved to be 2/5.

In two of the specimens the external characters of the fossil are well shown. The habit of the stem, clothed with the long, almost vertical, overlapping leaf-bases, may have been not unlike that of some of the tree-ferns, such as *Alsophila procera*.

The vascular system of the stem consists of three (or locally four) steles, anastomosing and dividing at long intervals.

Each stele of *Medullosa anglica* is surrounded by a zone of secondary wood and bast, and shows the closest agreement in structure with the single stele of a *Heterangium*, so that the stem of this *Medullosa* might well be concisely described as a polystelic *Heterangium*.

The course of the leaf-trace bundles was followed very completely in consecutive series of transverse, and in longitudinal, sections. On becoming free the trace is a large concentric bundle; as it passes obliquely upwards through the cortex, the trace loses its secondary tissues, and undergoes repeated division into a number of smaller bundles, each of which has collateral structure. These collateral strands have in all respects the same arrangement of their elements as the well-known bundles of *Myeloxylon*.

The base of the leaf received a large number of bundles, consisting of the ultimate branches derived from the subdivision of several of the original leaf-traces. This distribution of the bundles is peculiar and unlike that in any known plants of Cycadean affinities.

The petioles branched repeatedly, the finest ramifications of the rachis having a diameter of about 1 mm. only, but retaining in essentials the "*Myeloxylon*" structure. The leaf was thus a highly compound one; the structure of the leaflets associated with the rachis, agrees well with that of the *Alethopteris* leaflets, figured by M. Renault.

The roots, never previously observed in any species of *Medullosa*, were of triarch structure, with abundant formation of secondary wood, bast, and periderm. The author is indebted to Mr. J. Butterworth and Mr. G. Wild, for specimens which have thrown important light on the connection between root and stem.

While *Medullosa* combines, in a striking manner, the characters of Ferns and Cycads, the author is not disposed to regard it as having lain very near the direct line of descent of the latter group. It is more probable, as Count Solms-

Laubach has suggested, that the Medulloseæ represent a divergent branch, which has left no descendants among existing vegetation.

Physical Society, February 10.—Annual General Meeting.—Mr. Shelford Bidwell, F.R.S., President, in the chair.—The report of the Council was read by Mr. H. M. Elder. Dr. Atkinson then presented the Treasurer's report, and showed that although there was only a small balance in the bank, the financial position had somewhat improved. The list of Fellows lost to the Society by death was read. After some remarks with regard to the library and the subscriptions, votes of thanks were passed to the Council, the auditors, and to the other officers of the Society. The President then moved a vote of thanks to the Chemical Society for the use of the rooms at Burlington House. Council and officers for the forthcoming year were elected as follows: President, Prof. Oliver J. Lodge, F.R.S.; vice-presidents who have filled the office of president, Dr. J. H. Gladstone, F.R.S., Prof. G. C. Foster, F.R.S., Prof. W. G. Adams, F.R.S., the Lord Kelvin, F.R.S., Prof. R. B. Clifton, F.R.S., Prof. A. W. Reinold, F.R.S., Prof. W. E. Ayrton, F.R.S., Prof. G. F. Fitzgerald, F.R.S., Prof. A. W. Rücker, F.R.S., Capt. W. de W. Abney, C.B., F.R.S., Shelford Bidwell, F.R.S.; vice-presidents, T. H. Blakesley, C. Vernon Boys, F.R.S., G. Griffith, Prof. J. Perry, F.R.S.; secretaries, W. Watson (Physical Laboratory, South Kensington) and H. M. Elder (50 City-road, E.C.); foreign secretary, Prof. S. P. Thompson, F.R.S.; treasurer, Dr. E. Atkinson; librarian, W. Watson. Other members of Council: Prof. H. E. Armstrong, F.R.S., Walter Baily, R. E. Crompton, Prof. J. D. Everett, F.R.S., Prof. A. Gray, F.R.S., E. H. Griffiths, F.R.S., Prof. J. Viriamu Jones, F.R.S., S. Lupton, Prof. G. M. Minchin, F.R.S., and J. Walker.—The newly-elected President, Prof. Oliver Lodge, then took the chair, and an ordinary meeting was held. In his address he referred to the heavy death-roll of the Society during the past year, and to the tribute paid to the memory of John Hopkinson at Cambridge University. Prof. Lodge then commented on the quickness with which scientific discoveries were now applied to practice, and to the interest taken in such applications by men of science. He did not know whether this was due to the example and inspiration of Lord Kelvin, or to the progress of education among the public. He regretted that the public were so ignorant of scientific subjects. Rapidly reviewing the work done in physics during the past year, he spoke of the experiments of Righi, Preston, Michelson, and J. J. Thomson, and called attention to a prediction, lately published in NATURE by Prof. G. F. Fitzgerald, with regard to the probability of being able to obtain magnetic effects by passing circularly polarised light through absorptive media. After commenting upon the important position now occupied by terrestrial magnetism among the sciences, and the advantages of the publication now known as *Science Abstracts*, Prof. Lodge said there was one event of exceptional significance to physics, that had happened during the past year, an event of which science would feel the effect for centuries to come—the Government had decided to begin to establish a national laboratory. He wished to congratulate Sir Douglas Galton, and himself, on the speedy result of their urging the matter upon the British Association. He thought the thanks of the Physical Society were due to the Committee appointed by the Treasury, especially perhaps to Prof. Rücker, as acting-chairman of that Committee, and to Mr. Chalmers, who represented the Treasury, for the way in which the work had been brought to an issue. There was much for which the present Government deserved praise during the past year; he wished there could be added to their laurels the inauguration of a University for London. Prof. Lodge then went on to the specific subject of his address—the opacity of conducting media to light and to electric waves generally, emphasising the brilliant work of Mr. Oliver Heaviside in unifying phenomena apparently different, discussing the effect of boundaries, and dealing specially with the question, first attacked by Maxwell, of the theoretical opacity of gold-leaf. (This part of the address will be published in full in the *Phil. Magazine*.) Prof. Ayrton said, with regard to the attenuation of electric waves by the earth, that Mr. Whitehead, some months ago, came to the conclusion that when the primary and secondary coils were placed flat on the earth at a distance from one another, nearly all the energy of the primary was absorbed by the earth before reaching the secondary. The degree of absorption was so great that Mr. Whitehead had hesitated to publish his theoretical results until experiment should confirm them. Prof. Lodge concurred with Mr. Whitehead's result. Three cases were to be considered. In the first, one horizontal coil is superposed to the other, with sea-water or some other absorbing medium between them; in this case the absorption at moderate distances is not excessive. But, of course, if the coils are formed of cable sheathed with iron, as in the recent experiments made by the Royal Commission, the iron itself prevents the progress of electric waves from primary to secondary. In the second case the coils are wholly in the same horizontal plane. The earth, owing to its great magnitude, behaves almost as a perfect conductor; if the coils are now near the earth, there is no normal magnetic force between them—it is all tangential. In the third case the coils are opposed to one another, both being vertical, and near to the earth. The high conductivity of the earth is here acting to the advantage of wave propagation, for the image of the primary coil is in phase with the coil itself, and the total effect is approximately doubled.—Prof. Carey Foster then took the chair, and Prof. Oliver Lodge read a paper by Mr. Benjamin Davies, on a new form of amperemeter and voltmeter with a long scale. These instruments are already well known, although no account of them has actually been published. They are of the moving-coil, long-range, portable type, with a very uniform scale from zero to maximum. The magnetic circuit has only one air-gap, which is generally the space between a central cylinder of iron or steel and a concentric tube of iron, modified in various ways for facilitating the adjustment of the magnetic induction and the placing of the coil. The central cylinder is bored axially, and one side of the rectangular coil is pivoted at the top and bottom of the hole thus made. The second side of the coil moves in a circular path in the annular air-gap. Photographs of the instruments in several modified forms were exhibited. Prof. Ayrton said the instruments appeared to be very successful; he could bear witness of their value, particularly as regards the length of range. The general principle by which long-range was to be obtained on moving-coil, portable, instruments, was developed some ten years ago by M. Carpentier of Paris, who used a central magnet surrounded by a concentric hollow cylinder, with only one side of the coil in the magnetic gap between them; but it was not then a portable form of instrument, for the coil was suspended. Prof. Ayrton had himself worked in this direction in the "static station-voltmeter," in that instrument there were three magnetic circuits arranged to give staticism; this was described in 1892 or 1893.—The Vice-President (Prof. Carey Foster) proposed a vote of thanks to the author, and the meeting adjourned until February 24.

Chemical Society, February 2.—Prof. Dewar, President, in the chair.—The following papers were read:—Maltodextrin, its oxidation products and constitution, by H. T. Brown and J. H. Millar. Pure maltodextrin, isolated from the products of starch hydrolysis, yields, on very careful oxidation, a carboxylic acid which the authors term provisionally maltodextrinic acid A, and to which they assign the constitution

$$C_{12}H_{21}O_{10}.O.C_{12}H_{20}O_9.O.C_5H_9O_5\,;$$

this on further oxidation yields a maltodextrinic acid B,

$$C_{12}H_{21}O_{10}.O.C_5H_9O_5$$

and maltose. The constitution

$$C_{12}H_{21}O_{10}.O.C_{12}H_{20}O_9.O.C_{12}H_{21}O_{10}<,$$

is assigned to maltodextrin, the sign < denoting the open carbonyl.—On attempts to prepare pure starch derivatives through their nitrates, by H. T. Brown and J. H. Millar.—The stable dextrin of starch transformations, and its relation to maltodextrin and to soluble starch, by H. T. Brown and J. H. Millar. A stable dextrin is obtained at an early stage in the diastatic transformation of starch, and yields a carboxylic dextrinic acid on cautious oxidation. The following constitutions are assigned to the dextrin and the dextrinic acid respectively:—

$$O_{39}\begin{cases} C_6H_{11}O_5 \\ (C_6H_{10}O_4)_{39} \\ C_6H_{11}O_5< \end{cases} \qquad O_{39}\begin{cases} C_6H_{11}O_5 \\ (C_6H_{10}O_4)_{38} \\ C_5H_9O_5 \end{cases}$$

Propylbenzenesulphonic acids, by G. T. Moody.—The chemistry of the so-called nitrogen iodide. Part I. The preparation and properties of nitrogen iodide, by F. D. Chattaway and K. J. P. Orton. Well-defined crystals of nitrogen iodide are slowly

deposited on adding ammonia to dilute potassium hypoiodite solution; they are copper-coloured and have a density of 3·5. Part II. The action of reducing agents on nitrogen iodide, by F. D. Chattaway and H. P. Stevens. Part III. The composition of nitrogen iodide, by F. D. Chattaway. Nitrogen iodide, however prepared, has the composition $N_2H_3I_3$. Part IV. The action of light on nitrogen iodide, by F. D. Chattaway and K. J. P. Orton. Nitrogen iodide is decomposed by light, yielding nitrogen and hydrogen iodide; slight hydrolysis also occurs with formation of ammonium hypoiodite and ammonia. Part V. The action of alkaline hydrates, of water and of hydrogen peroxide on nitrogen iodide, by F. D. Chattaway and K. J. P. Orton. Alkaline hydrates hydrolyse nitrogen iodide with formation of ammonia and an hypoiodite; some decomposition occurs simultaneously, nitrogen and hydrogen iodide being produced. Water causes a similar decomposition, but the hypoiodous acid and hydrogen iodide in this case react with liberation of iodine. Hydrogen peroxide in potash solution decomposes nitrogen iodide with formation of ammonia, potassium iodide and a little iodate, whilst oxygen and nitrogen are evolved. Part VI. The action of acids on nitrogen iodide, by F. D. Chattaway and H. P. Stevens. Part VII. Theory of the formation and reactions of nitrogen iodide, by F. D. Chattaway and K. J. P. Orton. Iodine and aqueous ammonia react with formation of equimolecular quantities of ammonium iodide and hypoiodite; the latter then decomposes with formation of nitrogen iodide in accordance with a reversible reaction. —An isomeride of amarine, by H. L. Snape and A. Brooke. The action of chlorosulphonic acid on paraffins and other hydrocarbons, by S. Young.—Derivatives of dibenzylmesitylene, by W. H. Mills and T. H. Easterfield. Dibenzoylmesitylene on reduction yields dihydroxydibenzylmesitylene, which on further reduction gives dibenzylmesitylene.—On pseudocampholactone and pseudolauronolic acid, by F. H. Lees and W. H. Perkin, jun. Camphoric anhydride is converted by aluminium chloride in chloroform solution into isolauronolic acid and a new lactone, ψ-campholactone; the latter on hydrolysis yields a mixture of two isomeric acids of the composition $C_9H_{16}O_3$.—Nitrocamphor as an example of dynamic isomerism, by T. M. Lowry.—Position-isomerism and optical activity; the methylic and ethylic salts of benzoyl-, and of ortho-, meta- and paratoluyl-malic acid, by P. Frankland and F. M. Wharton. A considerable quantity of data respecting the rotations of the aromatic derivatives of methylic and ethylic malate is given.—Some regularities in the rotatory power of homologous series of optically active compounds, by P. Frankland.—On brasilin and hæmatoxylin, by A. W. Gilbody and W. H. Perkin, jun.

Zoological Society, February 7.—Prof. G. B. Howes, F.R.S., Vice-President, in the chair.—Mr. F. E. Beddard, F.R.S., read a paper on the cerebral convolutions of the gorilla, in which he reviewed our previous knowledge of the subject, and recorded his own observations on five brains of this animal which he had in his possession.—A communication from Dr. R. O. Cunningham, contained a note on the presence of supernumerary bones occupying the place of prefrontals in the skulls of certain mammals. These bones had recently been observed by the author in skulls of *Macropus giganteus* and *Phascolomys platyrhinus*.—Mr. G. E. H. Barrett-Hamilton read a paper on the mice of St. Kilda, of which he recognised two species—*Mus hirtensis*, sp. nov., a representative of *M. sylvaticus*, and *M. muralis*, sp. nov., representing *M. musculus*. Both of these species showed good distinctive characters from their well-known prototypes.—A communication was read from Prof. W. Blaxland Benham containing a detailed anatomical account of the structure of *Notornis*, based on the examination of a young female specimen of this bird recently received at the Otago Museum, Dunedin, New Zealand.—A communication was read from Mr. E. N. Buxton, containing some notes on the herd of bisons living in the Emperor of Russia's forest of Bielovege in Lithuania, which he had made during a visit to that place in the past autumn.—Mr. G. A. Boulenger, F.R.S., described two new species of lizards, under the names of *Lacerta jacksoni* and *Chamaesaura annectens*, from specimens contained in a collection of reptiles recently sent to the British Museum by Mr. F. J. Jackson, C.B., from the interior of British East Africa.—Mr. Boulenger read the second part of a memoir, entitled "A Revision of the African and Syrian Fishes of the Family *Cichlidae*." Owing to the large amount of material contained in collections recently received from Lake Tanganyika and the Congo, the author had been obliged to make an alteration in the plan of arrangement proposed in Part I. of the paper, and instead of dividing the family into nine genera, he had found it necessary to recognise nineteen genera. The present part contained a synopsis of all the known African and Syrian genera, an enumeration of all the species, and definitions of the genera *Tilapia*, *Steatocranus*, *Docimodus*, and *Paretroplus*, and their species, several of which were described as new.

EDINBURGH.

Mathematical Society, January 13.—Dr. Morgan, President, in the chair.—Elementary notes, by Mr. C. Tweedie.—Against Euler's proof of the binomial theorem for negative and fractional exponents; a note on continued fractions; a proof of the binomial theorem when the exponent is a positive integer, by Mr. R. F. Muirhead.

PARIS.

Academy of Sciences, February 6.—M. van Tieghem in the chair.—New researches relating to the action of sulphuric acid upon acetylene, by M. Berthelot.—The Hall phenomenon and Lorentz's theory, by M. H. Poincaré. The application of the theory of Lorentz to the Hall phenomenon leads to the conclusion that if the conductor is very strongly charged the electromotive force produced should change in sign. The author points out that although it would be of great interest to examine this experimentally, the result, if in agreement with the above conclusions, would not necessarily prove the Lorentz theory to be true, as a similar expression can be got in other ways.—Life in a confined space, by M. d'Arsonval. The apparatus described is so arranged that after the carbon dioxide produced by the breathing of the animal has been absorbed by soda lime, the diminution of pressure thus produced within the closed apparatus is caused to bring togetber chromic acid and hydrogen peroxide, the oxygen thus being automatically evolved, and the composition of the air remaining constant.—New facts relating to the sub-periosteal amputation of the elbow. Autopsy of an elbow totally amputated twenty-eight years ago, by M. Ollier. —Remarks by M. Lœwy on the presentation to the Academy of the eighth volume of the *Annales de l'Observatoire de Bordeaux*. —On a theorem of M. Hadamard, by M. A. Hurwitz.—Molecular theory of friction of polished bodies, by M. Marcel Brillouin.—Disruptive discharge in a vacuum. Formation of anode rays, by M. André Broca.—On the effects of light at very low temperatures, by MM. Auguste and Louis Lumière. A sensitised gelatino-bromide plant, immersed in liquid air and exposed for a short time to light, shows no appreciable tint on developing. Quantitative experiments showed that with plates of maximum sensibility, to produce equal effects, the exposure at -191° must be about four hundred times as great as at ordinary temperatnres. Plates immersed in liquid air and allowed to regain ordinary temperatures without exposure, undergo no change in any of their properties.—On the employment of sodium peroxide in the study of the respiratory function, by MM. Desgrez and Balthazard. In respiratory studies in a confined space, the products of the reaction between water and sodium peroxide (oxygen and caustic soda) are just those necessary to absorb carbon dioxide and replace it with oxygen.—Formaldoxim as a reagent for detecting minute traces of copper, by M. A. Bach. The chlorhydrate of trioximidomethylene $(CH_2{:}NOH)_3HCl$ gives in presence of caustic potash and traces of copper salts, an intense violet coloration. This violet tint is clearly perceptible in a solution containing one part of copper sulphate in 1,000,000 of water.—On the oxidation of some ureas, by M. Œchsner de Coninck.—Studies of the latent heat of vaporisation of piperidine, pyridine, acetonitrile, and capronitrile, by M. W. Louguinine. — New observations on the development of aromatic principles by alcoholic fermentation in presence of certain leaves, by M. Georges Jacquemin. The addition of an extract of vine-leaves containing glucosides to the must before fermentation causes a distinct improvement in the flavour of the resulting wine.—On methyloctenonal, by M. G. Leser. A study of the products arising from the action of hydroxylamine, aniline, and methylaniline upon this β-ketonic aldehyde.—On crystallised fibrin, by M. A. Maillard. The crystallised fibrin was noticed in some antidiphtheric serum tubes which had been standing for some months.—On the nature of the sugar in diabetic urine, by M.M. G. Patien and E. Dufau. The differences frequently obtained between sugar estimation, by Fehling and by the polariscope, are often due to the fact that lead sub-acetate does

not completely precipitate the lævorotatory substances present in urine. If acid mercurous nitrate is used as the precipitating agent, the two methods agree.—Influence of light on the formation of living nitrogenous substances in the tissues of plants, by M. W. Palladine.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 16.

ROYAL SOCIETY, at 4.30.—On the Reflex Electrical Effects in Mixed Nerve and in the Anterior and Posterior Roots: Miss Sowton.—The Characteristic of Nerve: Dr. A. D. Waller, F.R.S.—Observations on the Cerebro-spinal Fluid in the Human Subject: Dr St. Clair Thomson, Dr. L. Hill, and Prof. Halliburton, F.R.S.—The Thermal Deformation of the Crystallised Normal Sulphates of Potassium, Rubidium, and Cæsium: A. E. Tutton.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

LINNEAN SOCIETY, at 8.—On the Genus *Lemnalia*, Gray, with an Account of the Branching Systems of the Order Alcyonacea: Gilbert C. Bourne.—On some African *Labiatae*, with Alternate Leaves: J. H. Burkill and C. H. Wright.—Report on the Marine Mollusca obtained during the First Expedition of Prof. A. C. Haddon to the Torres Straits: James Cosmo Melvill and Robert Standen.

CHEMICAL SOCIETY, at 8.—On the Absorption Spectrum and Constitution attributed to Cyanuric Acid: W. N. Hartley, F.R.S.—Ballot for the Election of Fellows.

FRIDAY, FEBRUARY 17.

GEOLOGICAL SOCIETY, at 3.—Annual General Meeting.

QUEKETT MICROSCOPICAL CLUB, at 8.—Annual General Meeting.

SATURDAY, FEBRUARY 18.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S

MONDAY, FEBRUARY 20.

SOCIETY OF ARTS, at 8.—Cycle Construction and Design: Archibald Sharp.

IMPERIAL INSTITUTE, at 8.30.—Thirty-eight Years in Queensland: Hon. Sir, Horace Tozer, K.C.M G.

VICTORIA INSTITUTE, at 4.30.—Life: Prof. Beale, F.R.S.

TUESDAY, FEBRUARY 21.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R S.

SOCIETY OF ARTS, at 8.—Vitreous Enamels: Cyril Davenport.

ZOOLOGICAL SOCIETY, at 8.40.—On a Portion of Skin, named *Neomylodon listai*, from a Cavern near Consuelo Cove, Last Hope Inlet, Patagonia. With a Description of the Specimen by Mr. A. Smith Woodward: Dr. F. P. Moreno.—On the Formation of the Coral-Reefs of the North-west Coast of Australia: Surgeon P. W Bassett-Smith.—On a Collection of Reptiles and Batrachians made by Mr. J. D. La Touche in North-west Fokien, China: G. A. Boulenger, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Paper to be further discussed: The Lake Superior Iron Ore Mines, and their Influence upon the Production of Iron and Steel: Jeremiah Head and Archibald P. Head.

ROYAL STATISTICAL SOCIETY, at 5.—Comparative Statistics of Australasian Railways: Price Howell.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Demonstration with Violet Electric Waves for Actuating Photographic Apparatus, and for Photographing Lightning in Daylight: F. H. Glew.

WEDNESDAY, FEBRUARY 22.

SOCIETY OF ARTS, at 8.—Electric Traction, and its Application to Railway Work: Philip Dawson.

GEOLOGICAL SOCIETY, at 8.—On Varieties of Serpentine and Associated Rocks in Anglesey: Prof. T. G. Bonney, F.R.S., and Miss C. A. Raisin.—Remarks on the Genera *Ectomaria*, Koken, and *Hormotoma*, Salter; with Descriptions of British Species: Miss. J. Donald.

INSTITUTION OF MINING ENGINEERS (Stoke-upon-Trent), at 11.30.—The following Papers will be read or taken as read:—Historical Sketch of the First Institute of Mining Engineers: Bennett H. Brough.—Further Notes on Pit-props: Prof. H. Louis.—The Working of the Boiler Explosions Acts, 1882 and 1890: E. G. Hiller.—Alternating Currents and their possible Applications to Mines: Sydney F. Walker.—Notes on Coal-cutting Machinery: L. W. de Grave.—Safety Explosives: W. J. Orsman.—The Occurrence of Anhydrite in the North of England: C. E. de Rance.—Sulphur-Mines in the South of Spain: Arthur P. Wilson.

THURSDAY, FEBRUARY 23.

ROYAL SOCIETY, at 4 30.—*Probable Papers:* The Efficiency of Man, or Economic Coefficient of the Human Machine: Dr. Marcet, F.R S., and R. B. Floris.—Some Experiments bearing on the Theory of Voltaic Action: J. Brown.—Deposition of Barium Sulphate as a Cementing Material of Sandstone: Dr. F. Clowes.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

FRIDAY, FEBRUARY 24.

ROYAL INSTITUTION, at 9.—Coherers: Prof. Oliver Lodge, F.R.S.

PHYSICAL SOCIETY, at 5.—The Joule-Thomson Thermal Effect: E. F. J. Love.—(1) A Study of an Apparatus for the Determination of the Rate of Diffusion of Solids dissolved in Liquids; (2) Note on the Source of Energy in Diffusive Convection; Albert Griffiths.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Loss of Heat from Buildings: R. Gordon Mackay.

SATURDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—A Digest of Metabolism Experiments: Drs. Atwater and Langworthy (Washington).—De la Méthode dans la Psychologie des Sentiments: Prof. F Rauh (Paris, Alcan).—La Photographie Animée: E. Trutat (Paris, Gauthier-Villars).—Medical Works of the Fourteenth Century: Rev. Prof. Henslow (Chapman).—The Story of the Mind: J. M. Baldwin (Newnes).—Les Formes Épitoques et l'Évolution des Cirratuliens: M. Caullery and F. Mesnil (Paris, Baillière).—The Foundations of Zoology: Prof. W. K. Brooks (Macmillan).—Commercial Cuba: W. J. Clark (Chapman).—Remarkable Comets: W. T. Lynn, 7th edition (Stanford).—General Physiology: Prof. Max Verworn, translated and edited by Dr. F. S. Lee (Macmillan).—Siddhánta-Darpana, a Treatise on Astronomy: M. S. S. C. Simha, edited, &c., by Prof. J. C. Ráy (Calcutta).

PAMPHLETS.—Biblical Antiquities: C. Adler and I. M. Casanowicz (Washington).—Manchester Museum, Owens College Museum Handbooks, Publication No. 24 (Manchester).

SERIALS.—Bulletin de la Académie Royale des Sciences, &c., de Belgique, 1898, No. 12 (Bruxelles).—Bulletin from the Laboratories of Natural History of the State University of Iowa, December (Iowa).—Atlantic Monthly, February (Gay).—Encyklopädie der Mathematischen Wissenschaften, Band 1, Teil 1, Heft 2 (Leipzig, Teubner).—Quarterly Journal of Microscopical Science, January (Churchill).—Monthly Weather Review, November (Washington).—Among British Birds in their Nesting Haunts: O. A. J. Lee, Part xiii (Edinburgh).—Bulletin of the New York State Museum, November (Albany).—Quarterly Journal of the Geological Society, February (Longmans).—Agricultural Gazette of New South Wales, December (Sydney).—Himmel und Erde, February (Berlin).—Proceedings of the American Association, August 1898 (Salem).

CONTENTS. PAGE

THURSDAY, FEBRUARY 23, 1899.

THE NEW MINERALOGY.

A Text-Book of Mineralogy; with an Extended Treatise on Crystallography and Physical Mineralogy. By Edward Salisbury Dana. New edition, entirely rewritten and enlarged, with nearly 1000 Figures and a Coloured Plate. Pp. vii + 592. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1898.)

Manual of Determinative Mineralogy; with an Introduction on Blowpipe Analysis. By George J. Brush. Revised and enlarged, with entirely new Tables for the Identification of Minerals, by Samuel L. Penfield. Fifteenth edition. Pp. x + 312. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1898.)

Elemente der Mineralogie, begründet von Carl Friedrich Naumann (1873†). Dreizehnte Vollständig umgearbeitete Auflage von Dr. Ferdinand Zirkel. II. Hälfte: Specialler Theil. (Leipzig: W. Englemann. London: Williams and Norgate, 1898.)

THIRTY years ago the science of chemistry passed through a great revolution; new points of view were occupied by some investigators, and fresh lines of inquiry opened up by others; a general revision of the nomenclature and notation of the science became necessary, and thus arose what has been called "the New Chemistry." The last few years has witnessed a similar crisis in the history of mineralogy; crystallography has been reconstructed on a revised basis, and new views concerning the optical properties of crystals have rendered much of the old terminology of the science obsolete if not actually misleading.

It is a fortunate circumstance for English-speaking students and teachers of the subject that, in the first two volumes placed at the head of this article, we have a presentation of the science of mineralogy, in its modern aspects, which leaves little to be desired in the way of simplicity, precision and completeness. Prof. E. S. Dana, who is Professor of Physics as well as Curator of Mineralogy in the Yale University, gave the world in the year 1877 his "Text-Book of Mineralogy"—a very admirable introduction to the science. But as time passed on, and new methods of inquiry were invented, or old ones became obsolete, the necessary modifications and interpolations in the text of the book, when successive editions were called for, could not fail to mar the symmetry, and to some extent destroy the value of the work as a scientific treatise. Now the whole book has been rewritten, and, as its author is equally familiar with the methods and literature of physics, as well as with the technicalities and nomenclature of mineralogists—and these are by no means always in harmony with one another—a book has been produced which may be confidently recommended alike to students of the physical and the natural sciences.

Prof. S. L. Penfield, the Professor of Mineralogy in the Sheffield Scientific School of the Yale University, has similarly rewritten the well-known "Manual of Determinative Mineralogy, with an Introduction on Blowpipe Analysis," of Prof. G. J. Brush—a work which first appeared in 1874, and since that date has passed through no less than fourteen editions. It is not too much to say that, wherever determinative mineralogy has been taught to English-speaking students, the work of Brush has been adopted as by far the best and most thorough guide to the subject. Originally based on Von Kobell's "Tafeln zur Bestimmung der Mineralien," successive additions and corrections have given the work a character of its own; and without in any way impairing the efficiency or destroying the familiar features of the work, Prof. Penfield has brought the book up to date, and at the same time added much new matter which will be regarded by all teachers of the subject as being remarkable alike for lucidity and masterly treatment.

It is in the treatment of the difficult subject of crystallography that teachers and students will first appeal to these works for guidance at the present time: and they will not appeal in vain. During the last decade the six systems of crystallography have undergone complete disintegration; and an entirely new nomenclature has become necessary, in order to adequately express the great facts of isomorphism, heteromorphism, and of crystal-symmetry generally. The mathematical researhes of Sohncke, Wulff, Schönfliess, Federow, Barlow and others have shown that there are thirty-two—and only thirty-two—modes of molecular grouping possible in crystals; and, of these, exemplifications of all but three have already been observed, either among artificially crystallised salts or among natural minerals. The great majority of minerals crystallise in one or other of some eight or nine of these groups, however; while only five or six other groups are at all commonly represented among the rarer species of the mineral kingdom. It is to these groups then, and not to the more comprehensive systems of the crystallographer, that the attention of students of practical mineralogy must in future be directed; and we are indebted to Profs. Dana and Penfield for a simplification of the very cumbrous nomenclature hitherto adopted for the crystal groups. It is a distinct gain to speak of the "Pyrite-type" rather than of "pyritohedral-hemihedral forms" of the Isometric system, and of the "Quartz-type" rather than of 'trapezohedral-tetartohedral forms" of the Rhombohedral system.

The complicated mathematical questions involved in the derivation of hemihedral, tetartohedral and hemimorphic forms from holohedral ones, now lose much of their importance to the practical crystallographer. As Prof. Dana says:

> "The development of the various possible kinds of hemihedral (and tetartohedral) forms under a given system has played a prominent part in the crystallography of the past, but it leads to much complexity and is distinctly less simple than the direct statement of the symmetry in each case. The latter method is systematically followed in this work; and the subject of hemihedrism is dismissed with the brief (and incomplete) statements of this and the following paragraphs."

Students of the subject familiar with the methods of older treatises on crystallography, will find that Prof. Dana has been able—while giving an admirably clear and complete account of crystallographic methods and results in 144 pages of his book—to dismiss the subjects referred to in less than a single page.

Prof. Penfield's introduction to the study of crystallography, in which the subject is admirably treated in sixty-six pages of large print, will prove of not less interest to teachers, as showing how the great fundamentals of the modern presentation of the science can be dealt with in a very moderate space. Questions like those of the projection of crystals, and the calculation of axial ratios from goniometric measurements, which are well explained in Prof. Dana's text-book, are, of course, omitted in the smaller summary of crystallography by Prof. Penfield.

The subject of the optical characters of minerals is one which in the past has always proved to be of peculiar difficulty to students of mineralogy. The important memoir of Mr. Fletcher on "The Optical Indicatrix," has recently led physicists and mineralogists to reconsider the soundness of the postulates on which Fresnel based his theories of the action of crystals on light; and there can be little doubt that the near future will witness as complete a revolution in the nomenclature and methods of physical optics, as that which we have witnessed in the case of crystallography.

At the present time, however, it seems desirable to adopt the course followed by Prof. Dana, and to lay before the student both of the accepted methods of interpreting observed phenomena in connection with the passage of light through crystals of various kinds. We feel little doubt, however, that a future edition of the "Text-Book of Mineralogy" will break altogether away from the somewhat cumbrous and complicated terminology of Fresnel—hampered as it is by unnecessary assumptions—and that a more simple and rational method of treatment, in harmony with the methods of Mr. Fletcher, will be adopted in its place. The subject of physical optics finds no place in the more elementary work of Prof. Penfield.

The second half of the "Text-Book of Mineralogy" is a very judicious abridgement of the sixth edition of Dana's excellent "System of Mineralogy," the most important features of which were described in this journal at the time the work appeared. It is scarcely necessary to add that the present book has been brought well up to date.

The concluding portion of Prof. Penfield's book is made up of the well-known analytical tables for the determination of minerals. These tables have not only been completely revised, but have now had incorporated in them a great number of new species, including not a few which are of very rare occurrence. This increase in the number of species treated of has necessitated a complete rearrangement of the tables.

Prof. Zirkel, in bringing out a new edition—the thirteenth—of Dr. Naumann's well known "Elemente der Mineralogie," has recognised equally with Profs. Dana and Penfield the necessity for a complete change in the mode of treatment of the crystallographic and optical properties of minerals. As time has not yet permitted him to altogether rewrite the introductory portions of this old standard treatise, he has contented himself with issuing a revised edition of the second or systematic portion of the volume. The excellent features of this familiar text-book are well maintained, and some improvements are introduced into it, especially in the clearer and fuller treatment of the mode of occurrence of the different mineral species. We trust that the indefatigable editor, who has so long kept Naumann's book in the first rank of treatises of the science, may before long be able to supply us with that complete revision of the groundwork of the subject which he contemplates.

John W. Judd.

THE THEORY OF FUNCTIONS.

Introduction to the Theory of Analytic Functions. By J. Harkness, M.A., and F. Morley, Sc.D. Pp. xv + 336. (London: Macmillan and Co., Ltd., 1898.)

A NOTICE of the "Treatise on the Theory of Functions," by Profs. Harkness and Morley, appeared in Nature during 1894 (vol. xlix. p. 477). The object of that work, as of Prof. Forsyth's book on the same subject, was to present a complete view of the theory as a whole, and to follow out its various developments as far as space permitted. It would not be correct to regard either of them as written for a student who could be fairly described as a beginner. What Prof. Klein somewhere calls "a certain ripeness of mathematical judgment," which is just what a beginner does not possess, would be necessary in a reader who, without previous knowledge of the subject, could study such volumes with profit.

The new work by Profs. Harkness and Morley, the title of which is given above, is stated in the preface, and quite justly stated, to be in no sense an abridgment of their earlier and larger treatise. The authors say that their aim in writing it has been purely didactic, and that the book is intended to be an introduction to the subject for a student with no previous knowledge of it. The scope of the book will be best described by giving a short account of what it contains. It commences with an introductory chapter on ordinal numbers. The second chapter explains the representation of a complex number by means of an Argand diagram; and the third and fifth chapters deal at some length with the correspondence established between two planes, distinct or the same, by means of a lineo-linear equation between two variables. The fourth chapter discusses the logarithmic function from a special point of view. Chapter vii. deals with rational algebraic functions. In Chapters vi., viii. and ix. the idea of a limit, the conception of continuity, and the definition of convergence in connection with an infinite series are introduced. The conditions under which an infinite series has the properties of an ordinary sum are very completely investigated. Then follow five chapters which treat of power-series, and of some of the properties of an analytic function defined by a power-series and its continuations. Chapter xv. considers the representation of an integral function as a product of primary factors, each of which has a single zero. Next come a chapter on the integration of a function of a complex variable, and three chapters treating very briefly of the elliptic functions. Chapters xx. and xxi. deal with some of the properties of algebraic functions and with the construction and use of Riemann's surfaces in connection with them. The last chapter gives some account of the method of Cauchy and of the theory of the potential.

Opinions will and must differ as to what should be admitted into and what excluded from a book which is

to serve as an introduction to a subject of vast extent. It will be obvious from the preceding account of its contents that the space allotted in this book to algebraic functions is comparatively small. In the present writer's opinion it might with advantage have been considerably increased. Again, it seems a pity that the well-established use of a closed convex surface—a sphere, for instance—as a *locus in quo* for the geometrical representation of a complex variable has been omitted. The possibility of its use is indeed implied in one passage (p. 43), but the sphere is not actually used for the purpose of geometrical representation at all. The apparently exceptional nature of the value $x = \infty$ is undoubtedly at first a stumbling-block to the student, and the use of the sphere as an alternative to the plane would have been a help to him in this respect as well as in others. The excellent and detailed discussion of infinite series should certainly have been supplemented in the proper place by some corresponding discussion of infinite products. This point is referred to again below.

In the main, the authors have carried out the programme they have put before themselves well and thoroughly; their reasoning is in general rigorous and clearly expressed. Here and there however throughout the book there are signs of what appears to be undue haste in putting the matter together. Sentences not unfrequently occur which it is necessary to read more than once before their meaning is grasped; and sometimes, in passing from a sentence to the next, one experiences too great a sensation of transition. Moreover, haste appears occasionally to have led to inaccuracy. Two or three examples of this may be given.

The first chapter is intended to give the reader "a distinct image of a number divorced from measurement." On p. 3 occurs the sentence: "We can think of an infinity of objects as interpolated in the natural row, so that each shall bear a distinct rational number, and so that we can assert which of any two comes first." What is meant here by "an infinity of objects"? No test has been given in the sentences which precede the one quoted by which a finite assemblage of objects can be distinguished from an infinite assemblage; and without such a test the sentence quoted appears to beg the whole question discussed in the first chapter.

As a second instance, the opening sentences of Chapter xv. may be quoted.

"Let $a_1, a_2, \ldots, a_n, \ldots$ be a sequence of positive numbers, less than unity. Then

$$(1-a_1)(1-a_2) > 1 - a_1 - a_2,$$
$$(1-a_1)(1-a_2)(1-a_3) > 1 - a_1 - a_2 - a_3,$$

and so on.

"Hence if the series Σa_n has a sum s, the products $\Pi_1^n(1-a_m)$ form a sequence of numbers which (1) do not increase, (2) remain greater than $1-s$. Hence they have a limit; and the infinite operation $\Pi(1-a_n)$ is convergent; the limit is called the product, and is itself often denoted by $(\Pi 1 - a_n)$."

This is the first place in which an infinite product has occurred in the book, and what is implied in calling such a product convergent has not been explained. The statement that "the infinite operation $\Pi(1-a_n)$ is convergent" is therefore meaningless as it stands. Moreover, with the usual definition of convergence for an infinite product, the proof as given is inaccurate. For if Σa_n is greater than unity, all that has been proved is that $\Pi(1-a_n)$ is less than unity and greater than some definite negative quantity.

In an illustrative example on p. 232 the following passage occurs:

"By subtraction we have for $|x| = 1$, $x = -1$ excepted,

$$\operatorname{Log} x = \left(x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \ldots\right) - \left(\frac{1}{x} - \frac{1}{2x^2} + \frac{1}{3x^3} - \frac{1}{4x^4} + \ldots\right)$$
$$= \frac{x - \frac{1}{x}}{1} - \frac{x^2 - \frac{1}{x^2}}{2} + \frac{x^3 - \frac{1}{x^3}}{3} - \frac{x^4 - \frac{1}{x^4}}{4} + \ldots\text{"}$$

The rearrangement involved in passing from the second to the third line of this quotation is one which cannot be used with conditionally convergent series, as indeed the authors have most clearly shown in an earlier chapter.

It is not implied that a few inaccuracies such as the above really impair the value of the book. The authors have certainly made a most useful addition to the gradually increasing number of English text-books of modern type; and all teachers who have to introduce their pupils to the elements of function-theory will be grateful to them.

One further remark in conclusion. The reader of a mathematical text-book does not in general expect amusement as well as instruction; but surely, in such a work as that under notice, the *definition* of Log x by means of a piece of string and a cone which "should not be polished" (p. 47), has its humorous side.

W. BURNSIDE.

THE "IMPROVEMENT" OF FRUITS.

Sketch of the Evolution of our Native Fruits. By L. H. Bailey. Pp. xiii + 472; illustrated. (New York: The Macmillan Company. London: Macmillan and Co., Ltd.).

THE main purpose of this book is to give illustrations of the progress made in the development of the edible fruits of North America from their wild progenitors. This is what our fathers would have said; nowadays we express the same meaning in different words, and, as Prof. Bailey writes, we "attempt to expound the progress of evolution in objects which are familiar, and which have not yet been greatly modified by man." The United States offer an exceptionally good field for investigations of this kind. The wild plants are still there, relatively speaking unmodified by man. Cultivation and experiment are of recent date as compared with the long ages that have elapsed since "Noah began to be an husbandman" and prehistoric lake-dwellers dropped the seeds of the grape into the mud of Swiss lakes. Throughout Europe and Asia there is but one cultivated species of *Vitis* recognised, the *Vitis vinifera*, and from it have sprung the countless host of named varieties which are cultivated in the vineyards, and the smaller, though still considerable, numbers [that are grown in this country

under glass. The vine as known here is a composite product, representing the sum of the selection that has taken place during the course of the ages. But the selection has always been within the limits of one species, and for one particular purpose. As the vine is grown for its fruit, we might naturally expect the greatest amount of variation to be manifested in the berries. Systematists tell us that in such cases we should for comparative and historical purposes attach more weight to characters afforded by organs which have not been subjected to man's interference, than to those which are the result of intentional selection. This sounds plausibly, but in practice any one who studies the leaves of the vine will probably find in the foliage which has not been intentionally selected, as great, or even a larger, amount of variation than he will in the fruit.

In the case of the American vines the circumstances are different. There are twenty or thirty native species and a large number of varieties which have been classified by the author of this treatise. By the commingling of a few of these there have been produced within the comparatively short time that has been at the disposal of American cultivators, no fewer than eight hundred "domestic" varieties.

Of these varieties some are found specially suitable to one locality, or to one set of circumstances, whilst others adapt themselves to a different environment. It may seem to some mere ingenious trifling to concern oneself with all these morphologically petty variations. The naturalist knows better, the evolutionist finds himself placed in possession of an armoury of facts; whilst, to give only one illustration, the severely practical man is rendered happy by finding himself endowed with varieties which are relatively uninjured by Phylloxera, and on which, therefore, the European varieties may be engrafted. If a great plague has not been entirely stayed, at least its consequences have been evaded by this practical application of a variation in constitutional endowment.

On all grounds then, scientific, taxonomic or economic, the study of these variations assumes such great importance that naturalists have cause to be grateful to Prof. Bailey for the suggestive book that he has put at their disposal.

The principal aim of the book may be divined from our previous remarks. It is only necessary to add that the fruits treated of are the grape, the mulberry, the plums and cherries, the native apples, the raspberry, blackberry, and sundry other fruits. The history and evolution of these are sketched in a very instructive and interesting fashion. One thing comes out strongly, and that is that the amelioration of fruits in the United States is better secured by experiment with American species, than with those of European origin. The "environment" is more propitious to the native than to the introduced species.

This fact may, however, be set against others; such as the extraordinary vigour which some species are known to manifest when transferred to a new country, enabling them even to oust the aborigines! Again, in the old countries it is generally more immediately advantageous to improve what we have, than to break entirely new ground. In the one case we have everything to work up, in the other we begin with the advantages conferred by long years of inheritance. In this connection we are of course speaking from the point of view of the practical cultivator always clamouring for immediate results. If time is not of the essence of the matter, and only the sure but slow advance of science is concerned, then it would probably eventually be more fruitful to endeavour to turn to account the opportunities offered to us by the tens of thousands of plants which surround us, with only a few scores of which, at present, we avail ourselves.

Whatever be their needs or their predilections, naturalists will find Prof. Bailey's book a most valuable addition to their book-shelves.

LEGENDS OF THE NORTH AMERICAN INDIANS.

Creation Myths of Primitive America in relation to the Religious History and Mental Development of Mankind. By Jeremiah Curtin. Pp. xxxix + 532. (London: Williams and Norgate, 1899.)

THIS book is to a great extent a product of journalistic enterprise. In 1895 Mr. Curtin made an arrangement with the editor of a newspaper, by which he was to travel among some of the Indian tribes of North America and collect myth-tales; the most interesting of those that he might come across he was to send to the paper for publication at regular intervals. Mr. Curtin carried out his agreement. He travelled in California, Mexico and Guatemala, and the twenty-two myth-tales or stories here collected have all previously been published in the newspaper from which he obtained his commission. Science is, perhaps, better served when she is not written to order; but there can be no doubt that Mr. Curtin has collected a number of traditions that will be of great interest to students of the beliefs of savage and undeveloped races.

The myths published in the volume are some of those still current among the Wintus and Yanas, two stocks of Indians whose numbers have suffered considerable diminution during recent years. The Wintus formerly occupied the part of California on the right bank of the Sacramento from Mount Shasta to the northern shore of San Francisco Bay. Half a century ago they may have numbered some 10,000; to-day not more than 500 of them survive. The Yanas have suffered still more severely. Before the year 1864 they probably numbered some 3000; but in that year, in consequence of the murder of some white men in their district, the tribe was practically exterminated by the mining population of northern California; not more than fifty escaped. It is not improbable that before the advance of civilisation these tribes will soon cease to exist. Mr. Curtin has, therefore, done well in rescuing what still remains of their traditional system of belief before it disappears altogether.

The Indians have no very definite theory of creation, and their conceptions on this subject, which really affect their daily life to a considerable extent, can only be gathered from the long rambling stories, passed down with little change through many generations. The stories told by the Wintus and the Yanas resemble many others to be found among the various Indian tribes of North America, and those here published may perhaps, be conveniently, though rather roughly, classified

as "creation-myths." They do not give any systematised account of the origin of the universe, but in the form of tales describe the changes and metamorphoses by which the present world arose from a very similar one already in existence. According to this theory of creation there were people already in existence before the present race of men (that is of Indians) inhabited the earth. These first people were very numerous, and lived happily in a golden age through untold periods of time; they were in a sense divinities. At length disorder was introduced, and from the conflicts that resulted the present world arose. The creation-myths recount the methods by which this older world was changed into the world now existing. The changes were generally effected by struggle between hostile personages, one hero, perhaps, overcoming many opponents, and changing each into some beast, bird, plant or insect, the resultant beast or thing always corresponding in some power or quality with the personage from which it had been changed. Such conceptions are not peculiar to Wintu and Yana belief, but run through the traditions of most Indian tribes. We do not, however, agree with Mr. Curtin in thinking that similar traditions lie at the back of all the mythologies of the ancient world.

There is one slight defect in the general plan of the book that calls for notice, though it is, perhaps, due to the rather unusual circumstances which attended its birth. On opening the volume, a glance at the type and paper would suggest that the book was a novel or a collection of short stories; and, though a writer may make use of what type he likes so long as it is legible, in this instance Mr. Curtin's selection serves to indicate the spirit in which he has approached his work. He has, in fact, attempted to treat these legends from a literary rather than from a scientific standpoint, and it cannot be said that the result is altogether satisfactory. As might be expected, these stories, judged on their own merits as stories, are entirely lacking in interest, and their only value consists in the new material they offer to the student of folk-lore and comparative religion. Mr. Curtin, however, does not seem to be writing for such a reader. It is true that at the end some notes are added, but they omit a great deal of information necessary to any scientific collection of this class. For instance, no details are given as to the sources from which Mr. Curtin obtained the legends that he prints. We should like to know whether they were composed in their present form by Mr. Curtin himself from materials supplied at different times by several members of a tribe; or whether they are translations of actual stories told to him, and taken down by him at the time. We cannot help thinking that if full information on such points had been added, the scientific value of the book would have been considerably increased.

OUR BOOK SHELF.

An Illustrated School Geography. By Andrew J. Herbertson, F.R.S.E., F.R.G.S. Pp. vii + 263. (London: Edward Arnold, 1898.)

It would be difficult to produce a more elaborately and attractively illustrated volume of geography than that which Mr. Herbertson has constructed upon the basis of Mr. Frye's "Complete Geography," published in the United States three years ago. Every one of the quarto pages contains a pleasing collection of pictures, many of them striking and all of them instructive, and at the end of the volume are sixteen pages of coloured physical and political maps. The volume is thus a text-book, a picture-book, and an atlas combined; and for teachers who consider that books constituted in this way should be used in teaching geography, no better volume is available.

The work might be called a picture-book of geography; for the illustrations take up nearly as much room as the text. The pictures will show the young students who open the book what a large number of interesting people, places and things there are in the world, and will thus create a desire to read the text to learn something about the subjects illustrated. Let a pupil get the idea that geography consists mainly of definitions and statistics, and you will have a difficulty in ever making him believe that there is anything interesting in the study of the earth. But by introducing him to the subject through such an attractive means as Mr. Herbertson's volume affords, attention is at once secured.

The plan of the volume is as follows: After an introduction comes a section dealing with general geography, and including the principles of physical geography; biogeography, or the distribution of plants and animals; and the geography of mankind. In the second part, the special geography of the various countries of the earth is dealt with, beginning with the British Isles. It is intended that after the different aspects of geography referred to have been studied in a general way, the special geography of particular countries shall be considered, so that the principles taught by the first part shall be applied to the parts of the world studied in the second part. Teachers who think that principles should be deduced by pupils from facts will be able to begin at once with the special geography, and will introduce the generalisations where required. Whichever method is adopted, a truly educational course will be obtained; for the knowledge gained will show that many every-day phenomena of nature belong to geography, and carry instruction with them.

Notes on Cage Birds (Second series); *or, Practical Hints on the Management of British and Foreign Cage Birds, Hybrids, and Canaries.* Edited by W. T. Greene. Pp. xii + 340. (London: L. Upcott Gill, 1898.)

In spite of all that has been and will be said and written against it, the practice of keeping birds in confinement is so popular and so wide-spread, that there is no chance of its coming to an end. This being so, it is all-important that everything possible to alleviate the tedium of their confinement, and to preserve them in the best health, should be done for the captives. And as this is one of the objects of the little book before us, it may be commended to all bird-fanciers. Still, it is rather sad to read that "once a bird has lived in a cage or aviary for a time it is unfitted for a life of freedom, and usually quickly dies if permitted to fly away."

The book consists of a series of extracts from *The Bazaar*, written by various bird-fanciers since 1882, which have been classified and arranged by Dr. Greene; whose known experience affords sufficient guarantee for the selection. To an outsider, it is almost marvellous to note the number of species apparently ill-suited for captivity which have been made to thrive, and frequently even to breed, in this condition. And it is also satisfactory to learn that it is one of the objects of the "fancy" to endeavour to protect our native birds; especially species, like the starling, which are undoubtedly beneficial.

The appearance of the book is sadly marred by the introduction of hideous advertisements on the back of the title-page, &c.; but in other respects it is well and attractively got-up. R. L.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Stream of Alluvium.

In a private letter, Captain Roberts, Medical Officer at Gilgit, sends me the following information, which may interest some of your readers. He says that near Owir, which is near Drasan in the Turikho valley of Chitral, there is a curious object which he describes as a "glacier of alluvium." It fills the bed of a *nullah* which comes down from a ridge of Tirich Mir, and is free of snow. It appears to consist entirely of a moving mass of earth, &c. The top of the *nullah* is at about 12,000 feet and the foot of it at about 5000 feet above sea-level, and it is about five miles long. There is neither ice nor snow above or within this moving mass. It has an undulating, broken surface, and looks like a moraine-covered glacier, except that grass grows upon it in places, and even a few cultivation-terraces have been made upon it by the neighbouring villagers. Its breadth is about 200 yards. There is a stream in a depression on each flank of it, between it and the hillside. The villagers state that it is no new phenomenon. They say that it is always on the move. There are some trees upon it, and by the change in their position, as reported by the natives, it is concluded that the rate of movement is about 200 yards a year. The thing, therefore, is not any sort of mud avalanche. As above stated, parts of the surface are cultivated; but the natives have given up attempting to build houses upon it, because they always tumble down. Captain Roberts is attempting to get a photograph taken of this curious locality.

Martin Conway.

Chemists and Chemical Industries.

I see with pleasure that the notice of Dr. Fischer's pamphlet on technological education has been written by Prof. Meldola, one of the few men who by experience has a competent knowledge of the real needs of this country.

Dr. Fischer, of course, confines himself to one side of the question, and leaves out of sight the clever finance, the ingenious and somewhat Bismarckian trading methods which have combined with sound technical knowledge to place Germany in a position of superiority.

These equally demand the serious attention of our commercial men.

On the question of education its character and extent when required to furnish skilled chemical manufacturers—Dr. Fischer has the support of a distinguished master of chemical manufacturing and trading, as practised by German firms, in the person of Dr. Böttinger; and there can be no doubt that the German Government will listen to their advice, and endeavour to provide the education for which they ask.

But while Germany—thus awake to the necessity of maintaining her position—is preparing to act, what are we in this country doing?

Our so-called technical instructors will perhaps pride themselves that their efforts have fluttered the German dovecots. Nothing can be further from the truth. The real cause is almost entirely a financial alarm, caused by energetic commercial attacks upon the chemical trade now coming from three quarters—England, France, and America. Germany considers that this can best be met by improvement in technical knowledge on the part of the *officers* of the industrial army.

Meanwhile we are establishing technical schools, institutes, polytechnics, and so on, and teaching smatterings of science to workmen.

What is the result? Our well-equipped technical schools confine themselves to producing not technologists, but teachers.

Germany turns out 95 per cent. technologists, 5 per cent. teachers. Here things are reversed. The reason is plain. Here the persons consulted in such matters have been almost without exception academical chemists, chemical pedagogues. What the manufacturers want has not been asked; the professors know what is good for them, and will provide it. The national attitude so often denounced in the reports of our consuls on the failures of British traders in foreign markets. The London County Council appoints a technical instruction committee—all educationists; the committee does inquire as to the needs of chemical manufacturers, but selects as typical the trades of sulphuric acid and alkali making, in which the problems have been reduced to almost purely engineering ones, where magnitude of output and vast financial interests have reduced price until the margin for chemical movement has been contracted to almost nil. On the other hand, no representative of the organic chemical manufactures, in which these conditions are absolutely reversed, was deemed worthy of consultation.

And so we go on, and waste our energies on schoolboy work, and our money on polytechnic smattering, and the daily addition to those who must teach because no factory wants them.

Meantime every word that Fischer and Böttinger, Lunge and Meldola urge is true.

A technological faculty *is* wanted, and could be readily organised. But as long as the teaching of technical chemistry is controlled by those without any factory experience we shall flounder on. Chemical schoolmasters will abound. Our technologists must come from Germany, or go there to be "made," and the advertisement for "a chemist to act under the orders of the engineer of so and so, salary two guineas a week, one month's notice required and given," &c., will be the criterion by which we understand what is the British appreciation of the chemist.

115 Darenth Road, N., February 20. R. J. Friswell.

The perusal of Prof. Meldola's interesting review (Nature, vol. lix. p. 361) of Fischer's pamphlet on German chemical technology tempts me to recount an experience which befel me a year or so ago, and which in a way accentuates the contrast drawn by Prof. Meldola between chemical trade methods in England and Germany.

Finding that the collection of specimens of raw materials, bye-products and commercial products available for illustrating my lectures on applied chemistry at the institution at which I have the honour to teach was woefully inadequate, I very naturally made attempts to remedy the deficiency.

In the first place, I addressed nearly a hundred letters to various English manufacturing firms, asking for specimens of the kind described. Most of my letters were received with an expressive silence, and some elicited replies in which the writer's indignation at the impudence of my request was expressed with some vigour; in response to about half a dozen of my begging letters, however, I was presented with the desired specimens, and in some of these cases I am bound to say considerable pains had been taken to provide a really instructive series of specimens. For these I am truly grateful, and can respect the spirit in which the specimens were presented; but half a dozen sets of specimens are quite insufficient to illustrate the magnitude and scope of modern chemical technology. It should be re marked that some of the more churlish of my correspondentst suggested that if the specimens were needed we should buy hem; the well-known liberality of my governing body in educational matters is sufficient guarantee that the articles required would have been purchased long ago if they were on the market.

In my need I therefore addressed a second and similar series of letters, this time to German manufacturing firms: in almost all cases I received a notification that sets of specimens were being prepared. And very shortly I was inundated with packing-cases bearing the stamp "Made in Germany," and filled with comprehensive and admirably designed collections of specimens and patterns illustrating the particular branch of technology concerned. My lecture table is now daily well-stocked with specimens of German manufacture.

The explanation of the difference appears to be that the foreigner was quick to recognise that the young men who are my students to-day will to-morrow be in charge of works using large quantities of chemical products, and was quick to realise that the presence of his specimens on the lecturer's table is a better advertisement than costly notices of his goods in English trade journals; the English manufacturers, with a few noteworthy exceptions, did not accept this view of the matter.

William Jackson Pope.

Department of Chemistry, Goldsmiths' Institute, New Cross.

A SIMPLE SPECTROSCOPE AND ITS TEACHINGS.[1]

II.

Series.

MESSRS. RUNGE AND PASCHEN[2] first showed in 1890 that the spectra of lithium, sodium, and potassium were the summation of the spectra of various

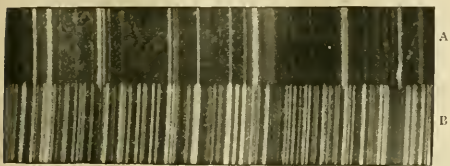


Fig. 7.—Parts of the spectra of (A) barium and (B) iron (from a photograph).

"series." Later they have shown that lead and other metals and the Cleveite gases follow suit.

Fig. 8.—Fluting of carbon.

A "series" of spectral lines may be defined as a sequence of lines the intensity of which decreases with

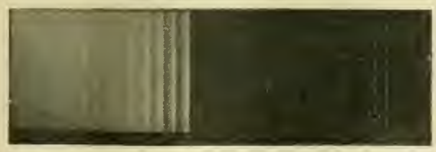


Fig. 9.—Fluting of magnesium.

the wave-length, and the number of vibrations of which may be determined by the formula—

$$A + B/n^2 + C/n^4,$$

where n is given the integers from three upwards, and the constants A, B, and C are determined for each element separately.

The fact that lines must close up to one another, as the violet end of the spectrum is reached, indicates that the character of a "series" is best brought under notice in the ultra-violet end of the spectrum. In the visible part of the spectrum the lines forming "series" are too far apart to be recognised as belonging to series.

As soon as it becomes apparent that a set of lines in the violet seems to form a series, computation will at once give the lines that belong to it in the visible part of the spectrum.

The accompanying diagram (Fig. 10) shows how the apparently irregular lines observed in the spectra of the Cleveite gases can be arranged into the most exquisite order when the six series of lines which build up the spectra are shown separately.

[1] Continued from p. 373.

[2] *Abh. k. Akad. Wiss.*, Berlin, 1890.

Some of these series are composed of triplets instead of single lines.

I wrote thus on this subject in 1879:—

"I am at present engaged in investigating this question of rhythm, and I have already found that many of the first order lines of iron may probably arise from the superposition or integration of a number of rhythmical triplets. All this goes to show how long the series of simplifications is that we bring about in the case of the so-called elementary bodies by the application of a temperature that we cannot as yet define.

"Indeed, the more one studies spectra in detail, and especially under varying conditions of temperature which enable us to observe the reversal now of this set of lines, now of that, the more complex becomes the possible origin. Some spectra are full of doublets; others, again, are full of triplets, the wider member being sometimes on the more, sometimes on the less, refrangible side."[1]

Mascart[2] had noted this recurrence of similar features in spectra ten years earlier.

Discontinuous Spectra with Dark Lines.

It is time now to make still another experiment with our needle and prism.

If we study sunlight—taking care again to shield the prism, by allowing a sunbeam to illuminate the needle, we get a spectrum of a kind differing from those we have seen before, inasmuch as the continuous band of colour is broken, it is full of dark lines; that is, some of the coloured rays are lacking; and hence images of the needle are not forthcoming in places. The positions of some of the chief dark lines lettered by Fraunhofer are shown in Fig. 11.

We now know that this result is produced by what is termed the *absorption of light*. To understand it we have only to look at a candle through glasses of different colours: a blue glass absorbs or stops the blue light, and only the red end of the spectrum remains; a red glass absorbs or stops the red, and only the blue end remains.

In these cases large regions of the spectrum are alternately blotted out as differently coloured glasses are used, but the absorption with which we have to do mostly is of a more restricted character; lines, that is single images of the slit, are in question.

One of the most important things that has been gathered from the study of these absorption effects is that if we look at a light source competent to give us a continuous spectrum, through any of the vapours or

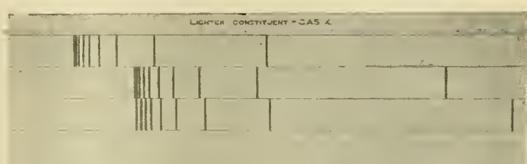


Fig. 10.—The series in the Cleveite gases.

[1] *Proc.* Roy. Soc., vol. xxviii., March 1879.

[2] In 1869, he wrote as follows: "Il semble difficile que la reproduction d'un pareil phénomène soit un effet du hasard: n'est-il pas plus naturel d'admettre que ces groupes de raies semblables sont des harmoniques qui tiennent à la constitution moléculaire du gaz lumineux? Il faudra sans

gases we have so far considered as producing bright lines; provided the light source is hotter than the gases or vapours, the particular rays constituting the bright line or discontinuous spectrum of each of the vapours as gases will be cut out from the light of the continuous spectrum.

Explanation of Absorption.

While in the giving out of light we are dealing with molecular vibration taking place so energetically as to give rise to luminous radiation; absorption phenomena afford us evidence of this motion of the molecules when their vibrations are far less violent. The molecules can only vibrate each in its own period, and they will even take up vibrations from light which is passing among them, provided always that the light thus passing among them contains the proper vibrations.

An illustration from what happens in the case of sound will help to make this clear. If we go into a quiet room where there is a piano, and sing a note and stop suddenly, we find that note echoed back from the piano. If we sing another note, we find that it also is re-echoed from the piano. How is this? When we have sung a particular note, we have thrown the air into a particular state of vibration. One wire in the piano was competent to vibrate in harmony with it. It did so, and, vibrating after we had finished, kept on the note.

This principle may be illustrated in another and very striking manner by means of two large tuning-forks mounted on sounding-boxes and tuned in exact unison. One of the forks is set in active vibration by means of a fiddle-bow, and then brought near to the other one, the open mouths of the two sounding-boxes being presented to each other to make the effect as great as possible. After a few moments, if the fork originally sounded is damped to stop its sound, it will be found that the other fork has taken up the vibration and is sounding, not so loudly as the original fork was, but still distinctly. If the two forks are not in perfect unison, no amount of bowing of the one will have the slightest effect in producing sound from the other. Again, suppose we have a long room, and a fiddle at one end of it, and that between it and an observer at the other end of the room there is a screen of fiddles, all tuned like the solitary one, we can imagine that in that case the observer would scarcely hear the note produced upon any one of the open strings of the solitary fiddle. Why? The reason is that the air-pulses set up by the open strings of this fiddle, in unison with all the others, would set all the other open strings in vibration; the air pulses set in motion by the vibration of the fiddle cannot set all those strings vibrating and still pass on to one's ear at the other end of the room as if nothing had happened to them.

Now apply this to light. Suppose we have at one end of a room a vivid light-source giving us all possible waves of light from red to violet. This we may represent as before by

V I B G Y O R

Also suppose that we have in the middle of the room a screen of molecules, say a sodium flame, capable of emitting yellow light,

Y

What will happen? Will the light come to our eyes exactly as if the molecules were not there? No; it will not. What, then, will be the difference? The molecules which vibrate at such a rate that they give out orange light, keep for their own purpose—filch, so to speak, from the light passing through them the particular vibrations which they want to carry on their own motions, and we shall have

V I B G   O R

as a result; the light comes to us minus the vibrations which have thus been utilised, as we may put it, by the screen of vapour. We have, in fact, an apparently dark space which may be represented thus;

V I B G **Y** O R

In the spectroscope we see what would otherwise be a continuous spectrum, with a dark band across the yellow absolutely identical in position with the bright band observed when the molecules of the vapour of which the screen is composed radiated light in the first instance. It is not, however, a case of absolute blackness, or absence of that particular ray, for the molecules are set in vibration by the rays which they absorb, and

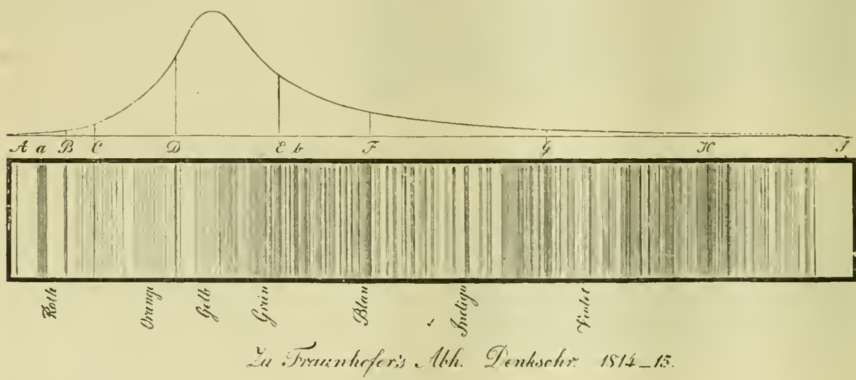


FIG. 11.—Copy of Fraunhofer's map of the solar spectrum.

doute un grand nombre d'observations analogues pour découvrir la loi qui régit ces harmoniques."

therefore give out some light, but it is so feeble as to appear black by contrast with the very much brighter rays coming direct from the original source.

This great law may be summed up as follows: *Gases and vapours, when relatively cool, absorb those rays which they themselves emit when incandescent;* the absorption is continuous or discontinuous (or selective) as the radiation is continuous or discontinuous (or selective).

I have referred to this matter at some length because in our light sources, in the sun, and in many of the stars we have light from a more highly heated centre passing through an envelope of cooler vapours, and on this account absorption phenomena are produced.

Our knowledge of the chemistry of the sun and stars is founded upon the exact coincidence of the bright lines seen in our laboratories with the dark lines noted in the spectra of those celestial bodies. The diagram shows the coincidence in the case of the double orange line of sodium vapour with dark lines in the spectrum of the sun.

FIG. 12.—The coincidence of the bright double orange lines of sodium vapour with the dark lines, D, of Fraunhofer.

Now if my reader has not hesitated to invest his or her sixpence in a prism, and has had the patience (no other quality is needed) to do what I have suggested, the way is open to read with intelligence most books involving spectrum analysis which he or she is likely to come across; terms such as

Spectrum	Discontinuous (or selective) spectrum
Continuous spectrum	Fraunhofer lines
Grating	Wave-length
Prism	Radiation
Spectroscope	Absorption
Slit	Series
Line spectra	
Fluted spectra	

should now have acquired a definite meaning, and I trust the expressiveness of the terms will be acknowledged while they are accepted as part of the future mental stock-in-trade.

NORMAN LOCKYER.

TO CALCULATE A TABLE OF LOGARITHMS.

HAVING been asked to give a short course of lectures to working men, which involved an account of logarithms and the slide-rule, I felt that, although not important, there would be some advantage in being able to show them how they could calculate a table of logarithms and a table of antilogarithms for themselves. Not that they need do so except as an interesting exercise, for I do not think it necessary that a man or boy must be able to make a tool before he is allowed to use it, but it would do them no harm to explain to them a simple method if I could invent one.

Of course on the usual assumption that one must first understand the exponential theorem, it is absurd to think that even average schoolboys who have been six years at mathematics can understand how logarithms are calculated. But if a schoolboy has been told what a logarithm means, and if he can extract a square root by the ordinary arithmetical method, and especially if he has had a sensible teacher and been allowed to use tables of logarithms, I think that he will have no difficulty in understanding the following method, and will rather enjoy working at it a little.

Let him find $10^{1/2}$, $10^{1/4}$, $10^{1/8}$, $10^{1/16}$, $10^{1/32}$, by repeatedly extracting square roots, getting out his answers to five significant figures, say. Let him now by multiplication calculate $10^{3/32}$, $10^{5/32}$, &c., right up to 10^1. He thus has a table of which I give the beginning and end.

Number.	Logarithm.
1·0000	0·00000
1·0746	0·03125
1·1548	0·06250
1·2409	0·09375
1·3336	0·12500
.	.
.	.
.	.
8·0584	0·90625
8·6596	0·09750
9·3057	0·96875
10·0000	1·00000

If he plots these values on squared paper he gets a curve which enables him to find the logarithm of any number.

If he wants answers right to four significant figures, it is well to draw only a small part of the curve on one sheet of squared paper. Thus plotting the first three points so that the curve joining them (using a slightly bent straight-edge) passes diagonally through a small sheet of squared paper, one of my students has found answers which are sufficiently correct to impress a student with the value of the method. I give here seven values taken at random from the curves of the early and the late parts of the table. This was the first time that he had tried the method, and the small errors in the fourth significant figures are not likely to occur if a man has more practice.

Number.	Logarithm as measured.	Correct logarithm.
1·035	·0149	·0149
1·110	·0452	·0453
1·151	·0610	·0611
8·950	·9520	·9518
9·175	·9626	·9626
9·345	·9706	·9705
9 825	·9923	·9923

Even with the very cheapest squared paper we can construct tables of logarithms and antilogarithms which will be quite accurate to three significant figures, and by taking twice the trouble and using $10^{1/64}$ we may get a table accurate to four significant figures, even with very cheap paper. Also it is to be noticed that by using $10^{1/128}$ and higher roots, we can find the logarithm of any particular number with any amount of accuracy desired.

JOHN PERRY.

Royal College of Science, February 16.

A NEW CURRENT INTERRUPTER FOR INDUCTION COILS.

May I call attention to the most remarkable electrolytic current interrupter due to Dr. A. Wehnelt, of Charlottenburg, which appears to me to be by far the most important improvement that has been made in connection with Ruhmkorff induction coils for many years. From a description in the *Electrical Review* for February 17 we have made in this laboratory one of these appliances, and tried it on a 10-inch Apps coil. The apparatus is of extreme simplicity, consisting merely of a glass vessel filled with dilute sulphuric acid, into which dip two electrodes. One of these is a plate of lead of considerable area. The other is a glass tube, through the end of which protrudes a short piece of platinum wire, sealed into the glass. The glass tube is open at the other end, and is filled with mercury, into which is dipped one of the wires from a source of continuous electric current; in our case the mains of the Westminster Electric Supply Company. The glass tube is immersed in the acid so that the platinum wire is some distance below the surface, and is within half an inch or so of the lead plate. No condenser is employed, the primary terminals of the coil being directly connected to the supply mains (100 volts) through the electrolytic cell, the positive current being arranged to pass through the cell from the platinum wire to the lead. On turning on the current a rapidly intermittent arc is seen to take place in the vicinity of the platinum wire, apparently between the latter and the dilute acid. Judging from the loud hum, the frequency must be some hundreds per second. At the same time, between the terminals of the secondary of the coil placed some five or six inches apart, a perfect torrent of sparks takes place, which follow one another so fast that the stream appears to be almost continuous. The effect is in fact very similar to that produced with a Tesla high frequency coil, but is much more constant and much less diffuse, while the stream of sparks curls about in a curious and distinctive manner, emitting all the time a very loud and continuous note.

The arrangement seems likely to have wide and important applications in connection with Röntgen-rays, wireless telegraphy, and many other purposes. It is a distinct step towards obtaining, from continuous currents, alternating currents of any desired high frequency without the necessity of moving parts. A. A. C. Swinton.

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NOTES.

In view of the advancement of zoological science to be expected from researches in the South Polar Lands and Seas, the Council of the Zoological Society of London have agreed, on the part of the Society, to contribute a sum of 200*l.* to the funds of the National Antarctic Expedition.

The seventh "James Forrest" lecture of the Institution of Civil Engineers will be delivered by Prof. J. A. Ewing, F.R.S., on Thursday, April 20, at eight o'clock, the subject being "Magnetism." The lecture will be repeated on Friday, April 21, at four o'clock, for the benefit of members and their friends.

We regret to announce that Dr. William Rutherford, F.R.S., professor of physiology in the University of Edinburgh, died on Tuesday morning, at sixty years of age.

At the annual meeting of the Russian Geographical Society, on February 2, the following medals were awarded:—The Constantine medal to Dr. Gustav Radde, the director of the Tiflis Museum, for his forty-five years' work in the study of Russia; the Count Lütke medal to I. I. Pomerantseff, for his researches into the forms of the earth's geoid in the province of Fergana; the Semonoff medal to M. Kleiber, for his investigations into the periods of high water in the Volga; the great gold medal of the Section of Ethnography to N. L. Gondatti, for his three years' work of exploration of the Land of the Chuckchis; the Przewalski medal to L. A. Jaczewski, for his physico-geographical researches in Siberia; and three small gold medals to M. Tachaloff, for his instruction of travellers in astronomical observations; A. A. Rostkovsky, for a map of population in the Bitol vilayet of Turkey; and N. A. Zarudnyi, for researches in Persia; a number of silver medals were awarded for minor works.

The Reale Istituto Lombardo announces in its *Rendiconti* the award of prizes as follows:—The Cagnola prize of 2500 lire and a gold medal of 500 lire has been awarded to Signor Angelo Battelli and Signor Annibale Stefanini for their joint paper containing a critical exposition of electric dissociation considered principally in regard to the experimental proofs of its deductions. For the Kramer prize, on an essay relating to the use of condensers in the transmission of electric energy by alternating currents and their construction for industrial purposes, two competitors entered, and prizes of 2500 lire and 1500 lire respectively have been awarded to Prof. Luigi Lombardi, of Turin, and Signor Giovanni Battista Folco, director of the electric tramways of Leghorn. For the Fossati prize, on some physiological point connected with the human encephalus, two competitors entered, and awards of 400 lire have been made to both—namely Dr. Domenico Mirto, of Palermo, and Dr. Carlo Martinotti, of Turin. For the Brambilla prize, given for the invention or introduction of some new machine or industrial process of real practical value, seven competitors entered. A gold medal and 500 lire has been awarded to Fratelli Boltri, of Milan, for their grain desiccators; a similar award to Premoli and Zanoncelli, of Lodi, for their preparation of Gaertnerised milk. Gold medals and 200 lire have also been given to Rossi, Enrico, and Co., of Milan, for their manufacture of varnishes, &c.; to Piola Alfredo, of Milan, for artists' colours; and to Pizzoni Pietro, of Milan, for the manufacture of baskets.

The prizes offered by the Reale Istituto Lombardo for future competition include prizes of the Institution for 1899 for a list of unusual meterological events that have been recorded from the earliest times, and for 1900 for an essay on collective property in Italy; two triennial medals for improvements in agricultural or industrial processes in Lombardy; a Cagnola prize and gold medal on the subjects chosen by the Institution, viz. in 1899, for an essay on Hertz's phenomenon, or the effect of active radiation or of products of combustion on the sparking distance in air, and in 1900 for a critical study of toxin and antitoxin; a Cagnola prize and gold medal for 1899 on one of the following subjects chosen by the founder: viz. the cure of "pellagra," the nature of miasma and contagion, the direction of flying balloons, and the methods of preventing forgery of writings; a Brambilla prize for industrial improvements in Lombardy; Fossati prizes for 1899 on the macro- or micro-scopical anatomy of the nervous system, for 1900 on the regeneration of peripheric nervous fibres in vertebrates, and for 1901 on the anatomy of the encephalus of the higher animals; a Kramer prize for an essay on the transmission of heat between the steam and walls of the cylinders of steam-engines; a Secco Comneno prize for 1902 for a description of Italian natural deposits of phosphates; a Pizzamiglio prize for an essay on the influence of socialistic doctrines on private rights; Ciani prizes for popular Italian books, a Tommasoni prize for a history of the life and works of Leonardo da Vinci; and a triennial Zanetti prize for some improvement or discovery in pharmaceutical chemistry.

THE Prince of Wales has accepted the office of President of the National Association for the prevention of consumption and other forms of tuberculosis.

THE annual meeting of the Society for the Protection of Birds will be held next Tuesday, February 28. The chair will be taken by Sir Edward Grey, Bart., M.P.

MR. J. HOOKEY has been appointed to succeed Mr. W. H. Preece, C.B., F.R.S., as engineer-in-chief of the Post Office, and Mr. J. Gavey has been appointed assistant engineer-in-chief and electrician.

PROF. KARL MÜLLER, one of the founders of *Die Natur*, the well-known German scientific weekly, and the editor of it until about three years ago, died on February 9, at the age of eighty-one. His botanical researches and many scientific writings have contributed much to the advancement of science.

THE Governor of Yeniseisk states that the native report regarding the Andrée expedition has been in no way confirmed either in Yeniseisk or in the region under the supervision of the inspector of mines for the northern Yeniseisk district. Though an exhaustive search has been made on the Upper Pit River, no traces of the expedition have been found.

WE learn from the *British Medical Journal* that the Paris Académie de Médecine is about to build itself a new house on a palatial scale. The plans have been drawn by M. Rochet, and all the architects who have seen them are said to have been unanimous in declaring that the building will be one of the finest in Paris. It is expected to be completed in two years.

THE International Congress of Mathematicians at Paris in 1900, of which a brief announcement appears in the *Revue Générale des Sciences* for February 15, promises to be one of the most important of coming events in the mathematical world. The Congress, which will be in conjunction with the Paris Exhibition from the 6th to the 12th August, will probably hold most of its meetings at the Sorbonne. Already upwards of 910 members and others have announced their intention to be present. The price of the tickets of membership has been fixed at thirty francs.

MR. STANLEY FLOWER seems to be making good progress with the reorganisation of the Zoological Garden at Gizeh, near Cairo, of which he has lately been appointed director. An Indian elephant has been received from Calcutta, and a fine specimen of the Gangetic crocodile has been presented by Captain Henderson, of the s.s. *Manora*. Large series of aquatic birds have also been lately obtained from Damietta, and have added much to the lively appearance of the garden, which is now much frequented by visitors from Cairo.

THE last letters received from Mr. John S. Budgett, who has been sent out on a scientific mission to the Gambia by the Zoological Society of London, are dated from Nianimaru, on the Gambia, about thirty miles below McCarthy Island, January 23. They announce that Mr. Budgett, who was in excellent health, was busily engaged in collecting fishes and birds. Of *Polypterus*, one of the objects of his special inquiries, he had obtained some large specimens, one of which was found to contain large ova. The Manatee (*Manatus senegalensis*) had been ascertained to ascend the river thus far.

THE anniversary meeting of the Geological Society was held at Burlington House on Friday last, February 17. The officers were appointed as follows:—President, Mr. William Whitaker, F.R.S.; vice-presidents, Dr. Henry Hicks, F.R.S., Prof. J. W. Judd, C.B., F.R.S., Prof. W. J. Sollas, F.R.S., and Rev. H. H. Winwood; secretaries, Mr. R. S. Herries and Prof. W. W. Watts; foreign secretary, Sir John Evans, K.C.B., F.R.S.; treasurer, Dr. W. T. Blanford, F.R.S. The medals and funds were awarded as announced on January 19 (p. 275). The President delivered his anniversary address, which dealt with various subjects in which geology has practical application.

AT the meeting of the Chemical Society on Thursday last, the President announced that Mr. C. E. Groves, F.R.S., had resigned the editorship of the Society's *Journal*, and that Dr. W. P. Wynne, F.R.S., had been selected to succeed him. The Council had recorded their sense of Mr. Groves' services to the Society in a vote of thanks, a copy of which would be engrossed on vellum and presented to him. It was announced that the following changes in the officers and Council were proposed by the Council: As president—Prof. T. E. Thorpe, F.R.S., *vice* Prof. James Dewar, F.R.S. As vice-presidents—Mr. C. E. Groves, F.R.S., and Prof. Thomas Purdie, F.R.S., *vice* Prof. F. R. Japp, F.R.S., and Prof. W. A. Tilden, F.R.S. As hon. secretary—Dr. Alexander Scott, F.R.S., *vice* Dr. W. P. Wynne, F.R.S. As hon. treasurer—Prof. W. A. Tilden, F.R.S., *vice* Prof. T. E. Thorpe, F.R.S. As ordinary members of Council—Mr. H. Brereton Baker, Prof. F. Clowes, Dr. G. T. Moody, and Prof. James Walker, *vice* Prof. Bedson, Mr. Hehner, Prof. McLeod, F.R.S., and Dr. Scott, F.R.S.

REFERRING to the recent landslip at Airolo, a Reuter telegram from Berne says: "With the weather becoming warmer fresh falls of rock have occurred at Sasso Rosso, near Airolo, one of them being of considerable magnitude. These falls confirm the view taken by geologists that the further slides will not take place all at once, but in sections varying in bulk from 5000 to 10,000 cubic metres. The fresh masses fell on the present accumulation of débris without causing any damage. The St. Gothard Railway is not endangered, and there is no question of the traffic being interrupted."

WE learn from *Science* that the Physical Society of Berlin, established in 1845, has decided to be known as the German Physical Society. The object of the Society is to advance physical science by the following means: (1) the publication of *Proceedings*, especially, for the prompt issue of short communications. (2) The publication of a year-book on the progress of physics. (3) Co-operation in the publication of the *Annalen der Physik und Chemie*. (4) Participation in the meetings of the Section of Physics, of the German Society of Men of Science and Physicians. (5) Regular meetings in Berlin, and (6) a journal club.

IN 1894 the Goldsmiths' Company made a grant of 1000*l*. to the conjoint Board of the Royal Colleges of Physicians and Surgeons for the purpose of further experiments in connection with the anti-toxin treatment of diphtheria, with the stipulation that a supply of the best possible serum should be supplied for the gratuitous treatment of poor patients, especially children, suffering from diphtheria. In a report to the Company, Sir Walter S. Prideaux has expressed the opinion that the Company would take a wise and beneficent step if they were to make a further grant to the conjoint Board, adding, "There can be no question that the grant made in 1894 has proved not only of much importance to science, but has also been of great value to suffering humanity amongst the poorer classes." Upon consideration of the report the Goldsmiths' Company have made a further grant of 500*l*. to the conjoint Board, making the same stipulation as before, that a supply of the best possible serum shall be supplied for the gratuitous treatment of poor patients.

THE Rev. M. Dechevrens, S.J., director of the St. Louis Observatory, Jersey, has sent us a letter with reference to Mr. W. H. Dines's recent paper on the connection between the

winter temperature and the height of the barometer in north-west Europe. Mr. Dines concludes, and M. Lancaster, of Brussels, agrees with him (see p. 377), that in winter it is just as likely to be cold when the barometer is below the average as when it is above the average. This result is opposed to the current theory, but the Rev. M. Dechevrens holds that the phenomena concerned are only an extension of the general theory of variations of temperature in cyclones which he has for some years been bringing before the attention of meteorologists. A brief description of his conclusions as to the variations of air temperature in cyclones, and their cause, will be found in NATURE of July 28, 1898 (vol. lviii. p. 301).

DURING the fine weather of last week Mr. Walter Garstang successfully accomplished the first of his periodic surveys of the physical and biological conditions of the English Channel for the current year, an investigation in which he has been assisted by a grant from the British Association and by the use of apparatus belonging to the Government Grant Committee of the Royal Society and the Marine Biological Association. Mr. Garstang left Plymouth on Friday last in the steam tug *Stormcock*, and returned home late on Sunday. Stations were established in mid-Channel (50 fathoms), off Ushant (60 fathoms), off Parsons Bank, seventy miles west of Ushant (80 fathoms), and off Mounts Bay (50 fathoms). Serial temperature soundings were taken, and collections of plankton were made at the surface and in 40 fathoms at each of these stations. The deep water plankton collections were made by means of a pump and 40 fathoms of armoured suction hose. Surface collections were also made with the same apparatus. The quantity of water pumped on each occasion was determined with all possible accuracy, and the filtered samples were preserved for future examination without accident, thus admitting of a quantitative analysis for a comparative statement of the results obtained. Surface collections were also made at each station by means of tow-nets for comparison with the results obtained by the pump. A heavy ground swell, crossed by a stiff north-westerly breeze, was encountered between Ushant and Parsons Bank, but in other respects the weather was all that could be desired. The temperature results display a remarkable uniformity for all depths at each of the stations. The warmest water was met with to the westward, while the mid-Channel water was found to be warmer than that bathing the English and French coasts, thus confirming Mr. H. N. Dickson's results as to the course of the axis of high temperature in the Channel. It is intended to repeat the investigation at the same stations during May, August and November of the present year, in order to provide material for a complete account of the seasonal changes, as well as the horizontal and vertical distribution of plankton and temperature in this region of the Channel.

FROM a report in the *Adelaide Chronicle*, it seems that the iguana lizard, hitherto supposed to be perfectly harmless, except in poultry yards, has been found to be the slaughterer of lambs. Several sheep-owners have caught the iguana in the act of killing lambs, so there can be no doubt that this reptile must now be classed amongst the enemies of the pastoralists. The scarcity of opossums has probably driven the iguana to attack lambs for food. Pastoralists, who since the discovery have watched their lambs closely, say that even very small iguanas will attack a lamb, and they further state that any lamb so bitten will not recover.

THE presidential addresses delivered before the various sections of the American Association at the forty seventh meeting and fiftieth anniversary, held at Boston, Massachusetts, last August, and abstracts of the papers communicated, are printed in the volume of *Proceedings* (vol. xlvii.), which has just been published by the permanent secretary, Dr. L. O. Howard. The volume runs into 658 pages, and contains many papers of scientific interest and value. This year's meeting of the Association will be held at Columbus, Ohio, the president for the meeting being Prof. Edward Orton, of Ohio State University.

THOUGH the age of the implements or "palæoliths" from the Trenton gravels has been the subject of much controversy, little attention appears to have been given to the human remains from the same beds. Dr. Frank Russell has, therefore, made a detailed study of these remains in order to determine whether or not they resemble the remains of recent Indians of the region. The Delaware Valley was occupied by the Lenni Lenapé until 1737; and Dr. Russell concludes that the crania found near the surface, at least about Trenton, are the skulls of members of this tribe, or of other modern Indians. The paper in which the remains are discussed appears in the *American Naturalist*.

EXPERIMENTS to determine the density of ice are described, by Prof. Edward L. Nichols, in the January number of the *Physical Review*. From his own investigations, Prof. Nichols concludes that the natural ice he used in the form of air-free icicles, and in the massive form of ice-blocks cut from the surface of a frozen pond, had a density at 0° of 0·9180. Artificial ice produced by the use of carbon dioxide and ether was found to have a density not far from 0·9161. There appears to be no doubt that natural ice obtained from the surface of frozen ponds and rivers and in the slow formation of icicles possesses a density greater than that of artificial ice by about two parts in a thousand.

MR. CHARLES S. TOMES, F.R.S., describes, in the *Quarterly Journal of Microscopical Science*, an investigation on the differences in the histological structure of teeth of fishes of the family Gadidæ. The object of the investigation was to ascertain the extent of the variation in structure of the teeth of various Gadidæ, and to see how far these differences coincide with the lines of classification on general grounds. The conclusion arrived at is that the differences of tooth structure only to a limited extent follow the lines of the general affinities of the genera. Mr. Tomes also remarks: "The teeth of the Gadidæ appear to furnish an argument against the adequacy of the purely mechanical theory of the evolution of tooth forms, so warmly advocated by Cope under the name of kinetogenesis, and adopted in its entirety by a large number of the American school of naturalists."

THE Pilot Chart of the North Atlantic Ocean, issued by the Hydrographic Office of the United States for February, reviews the state of the weather from December 20 to January 20. In many localities the weather in the Atlantic was very severe; gales of hurricane force accompanied with violent squalls were frequently reported. The tracks of fifteen storms are traced upon the chart; the centres of these disturbances were for the most part to the north of the transatlantic routes, moving north-eastward, and following each other in rapid succession. Several of them are shown to have traversed the whole of the North Atlantic. Nearly all of them passed to the northward of our islands, although their influence would be felt on our extreme north-west coasts. The principal exception was the storm which was central over England on December 29, which after reaching longitude 30 W., took a nearly direct westerly course; this disturbance developed off the American coast on December 26. Reports from the Newfoundland coast indicate a rapid southerly movement of the Arctic ice floe. Some immense icebergs were reported 200 miles S.E. of St. John's, Newfoundland, in the latter part of January, directly in the track of shipping.

ABOUT four years ago, Prof. Wilhelm von Bezold pointed out, from theoretical considerations, that both winter and night thunderstorms, compared with summer and afternoon thunderstorms, should be much more frequent on the sea and the coasts than inland, but that this effect could scarcely be expected in the case of sea-coasts where the paths of the cyclones are generally from the land to the sea. The work of Messrs. Mohn and Hildebrandson on Norway and Sweden, and of Dr. Meinardus on the open sea, is in general agreement with this theory, as also are other more or less complete reports for different places. Prof. H. D. Stearns has made a further investigation of the subject, and gives his results in the U.S. *Monthly Weather Review*. His tables and curves, showing monthly percentages of thunderstorms on coasts and inland in various parts of the world (the British Isles included), establish a general law that the percentage of winter thunderstorms decreases in passing from a coast inland in the general direction of the prevailing cyclonic winds.

THE spectroscopic analysis of minerals is in most cases undertaken by using the electric spark as the heat source for volatilising the substance. Considerable difficulty is experienced in the case of those minerals which are non-conductors, such as the felspars. M. A. de Gramont (*Bull. de la Soc. Franc. de Mineralogie*, March, April, and May 1898) has overcome this by first mixing some easily fusible salt with the powdered mineral, and then heating the mixture with a Bunsen burner, when the mineral is generally dissolved in the salt, and the electric spark is passed from the mass while molten. In most cases, he uses one or more Leyden jars in the secondary circuit to raise the temperature sufficiently. The salts he finds best adapted are the carbonates of lithium and sodium, chiefly on account of the simplicity of their spectra, which have, of course, to be eliminated from the results before the spectrum of the mineral itself can be mapped. For this purpose he gives tables of the principal wave-lengths in the spectra of these salts, and also of the more commonly occurring simple bodies. He then describes in detail the characteristics of the spectra observed with the non-conducting minerals, of which he has examined some twenty-five different specimens.

FROM a paper dealing with the mica mines in Bengal, contributed by Mr. A. Mervyn Smith at the meeting of the Institution of Mining and Metallurgy on February 15, it appears that the industry is a very ancient one, the methods of mining the mica and preparing it for market having been in use for centuries. The mica occurs in pegmatite veins running through foliated rocks, and is taken out from open cuts made in the decomposed granite, and abandoned as soon as solid rock is reached. The miners are a local tribe called Bandathis, men, women and children all working at the mines in the dry months when there is no agricultural work in the fields to be done. The books of mica are chiselled out, the work being aided by large fires when the pegmatite is hard, and split into sheets of about one-eighth of an inch in thickness. The rough edges are then trimmed, and the sheets sorted into four qualities and several sizes; the best "ruby" mica, which is unaffected by high temperatures, being worth 20*s.* per pound when in large sheets, while small sheets only fetch 2*d.* per pound. The uses are well known, and the consumption is now increasing, but appears to have been greater in early times. The output was given by Dr. McClelland in 1849 as 100,000 maunds, or about 73,000 cwts., and is estimated by Mr. Mervyn Smith at less than 20,000 cwts. in 1895. He also states that nearly all the mica used in the arts comes from these mines.

IN the *Verhandlungen der k.k. geologischen Reichsanstalt* (Wien) for November 30, 1898, Herr A. Bittner contributes an interesting description of some fish remains collected by him from the Hallstätter Kalk of Mühlthal bei Piesting. Though the fossils here dealt with consist only of isolated teeth, every such addition to our knowledge is welcome, for, as pointed out by the author, these remains are but rarely met with in the Alpine Trias. While Rhætic forms have been recorded by Gümbel, and later by Zugmayer, from the Kössener Schichten, and Stur discovered a *Ceratodus* skull, later described by Teller, at the base of the Lunzer Schichten, no fish remains whatever, as far as the author is aware, have hitherto been chronicled from the Hallstadt limestones. The teeth, illustrated by text figures, are referred to the genera *Sargodon* and *Hybodus*, and are regarded as representing new species. In the same number of the *Verhandlungen* are papers by Dr. W. Salomon, discussing the age of the Asta granite; and Herr F. Kerner, who describes several Culm plants from the Dachschiefer near Johannesbad. Herr F. Schaffer records the occurrence of Miocene strata in the neighbourhood of Siegenfeld, and, on the evidence of fossils obtained from well sinkings, correlates the beds with the Tegel of Baden.

M. PAUL MILLET, writing in the *Revue scientifique* of January 14, discusses the causes of the disappearance of insectivorous birds and the best means of prevention. These causes are twofold in nature, viz. natural causes tending to maintain the balance of nature, and artificial causes due to human agency, to which latter the author chiefly attributes the phenomenon in question. The means of prevention are also of two kinds: methods of a persuasive character, and legislative measures. Among the former may be cited (1) the teaching of ornithophily in schools and colleges; (2) the posting of printed notices; (3) introduction of books on birds into public libraries; (4) recommendation to teachers in primary schools to insist on the utility of preserving birds and nests. These means are all considered quite inadequate to deal with the evil, and M. Millet considers it desirable to enforce existing laws on the subject (1) by the passing of a regulation forbidding the capture or sale of birds smaller than the lark; (2) by suppressing the privileges sometimes granted for snaring birds in snowy weather; (3) by forbidding the sale of instruments for capturing small birds; (4) by enforcing vigilance on the part of gendarmes and police throughout the year; (5) by the seizure of small birds at the octroi, in railway stations or in markets; (6) by taking similar measures against milliners; (7) by the protection of birds of passage when landing, a measure in which Custom-house officers could assist; and (8) by killing birds of prey and animals which attack eggs. It is suggested that the French "Ligue Ornithophile" might materially assist in such measures, the need of which is far more urgent in France than in this country.

To rid beech-trees of that dangerous parasite *Cryptococcus fagi*, which causes much anxiety to foresters, many methods have been tried. Solutions of soft soap, methylated spirit, and so on, applied to the skin of the tree, are of no avail when the bark has become much decayed. External remedies having in such cases proved useless, Mr. John Shortt, the head forester upon the estate of Sir Matthew White Ridley, Bart., has tried internal ones, and the results are mentioned in the recently-published volume of *Transactions* of the English Arboricultural Society. Thirty years ago several trees which were in the last stages of decay were selected, and three holes were bored in the trunk of each, about two feet from the ground, slanting downwards, and converging towards a common centre. Sulphur, saltpetre, and other substances were placed in the holes —sulphur in one tree, saltpetre in another, and something else in a third—and the holes were then securely plugged. All the trees died except the one that had been treated with sulphur. Since these experiments several other beeches have been treated in the same way, and with equally satisfactory results. The

operation, it may be added, is performed in the autumn. These experiments in practical forestry have excited great interest among foresters. It is hoped that the matter will be taken up in a scientific way, and that the chemical action of the impregnated sap will receive elucidation in a form which will be of practical use to the owners of woodlands throughout the country.

Bulletin No. 4 (vol. iv.) of the Laboratories of Natural History of the State University of Iowa is entirely occupied by two papers: On the Cyperacea of Iowa, by Mr. R. J. Cratty; and on American Uredineæ (part 2), by Messrs. J. C. Arthur and E. W. D. Holway. Both papers are well illustrated.

WE have received the *Proceedings* of the Agricultural Research Association for 1898. In its report, the Committee calls especial attention to the experiments carried on by the Association, under the direction of Mr. Thomas Jamieson, on the cross-fertilisation of the oat, resulting in the production of new valuable varieties by natural cross-pollination rather than by any artificial assistance.

AMONG the lectures to be delivered at the Royal Victoria Hall, Waterloo Road, on Tuesday evenings during March, are the following:—March 7, "The Scenery of Alpine Lands," Mr. E. J. Garwood; March 14, "The Atmosphere," Morris W. Travers; March 28, "Mont Blanc, the Great White Mountain," Mr. J. Russell.

AMONG the papers in the winter number of *Brain*, is the presidential address delivered to the Neurological Society by Prof. Victor Horsley, F.R.S., on the determination of the energy developed by a nerve centre, and a contribution on an experimental study of visions, by Dr. Morton Prince.

UNDER the title of "An experiment in commercial expansion," Mr. Leonard Courtney, M.P., delivered in December last a presidential address to the Royal Statistical Society, dealing with the economic lessons taught by a study of the commerce and development of the Congo Free State. The address is now published In the Society's *Journal*.

A BRIEF summary has been published at Philadelphia of a voluminous report drawn up for the Japanese Government by Tentearo Makato on "Japanese notions of European political economy." The report contains, *inter alia*, a summary of the main views of leading political economists as they presented themselves to the mind of the Japanese Commissioner.

A BI-MONTHLY magazine devoted to the study and protection of birds, edited by Mr. Frank M. Chapman, and published by the Macmillan Company, New York, has just appeared under the title of *Bird Lore*. The journal will be the organ of the Audubon Societies, and will provide students of bird-life with interesting articles and notes and pictures. The fact that during the past six years New York and Boston publishers have sold more than seventy thousand text-books on birds, promises success to this popular journal of ornithology.

IN a recent note in these columns attention was drawn to the reported discovery by M. Jaubert of a substance capable of removing from the air of a closed chamber the carbonic acid, water vapour and other irrespirable gases produced by a living animal within the chamber, and at the same time of keeping up the supply of oxygen. In the *Comptes rendus* for February 6, the subject is referred to in two communications. MM. Desgrez and Balthazard describe experiments made with sodium peroxide. This substance is acted upon by water according to the following equation, $Na_2O_2 + H_2O = 2NaOH + O$. The caustic soda produced will, of course, absorb carbon dioxide. A guinea-pig weighing 400 grammes, when enclosed in 10 litres of air, was asphyxiated in from two to two and a half hours: but under similar conditions when sodium peroxide was placed in the enclosure, and water allowed to drop on it, a guinea-pig showed no diminution of vitality at the end of four hours. To see if the moisture of expired air would suffice to act on the peroxide, two guinea-pigs were enclosed in 30 litres of air with 66 grammes of peroxide. They were taken out alive at the end of ten hours, whereas two others of the same weight died at the end of four hours in the absence of peroxide. Finally a dog weighing 6·5 kilogrammes, enclosed with 70 litres of air and 200 grammes of peroxide, gave unequivocal signs of life at the end of six hours. The peroxide was only attacked superficially in the last cases, owing probably to the formation of a protective layer of carbonate.

IN discussing the above experiments, M. d'Arsonval points out that seventeen years since he proposed an effective method of achieving the same end. The animal is enclosed hermetically in a tubulated receiver; the upper part of this contains a receptacle filled with pieces of soda-lime; through the tubulus a solution of hydrogen peroxide, coming from a Mariotte's bottle, is conducted by a tube so as to drop into a strong solution of chromic acid. The apparatus works automatically, for as the animal breathes and the carbon dioxide and water are absorbed by the soda-lime, the pressure falls and the Mariotte's bottle comes into action. The hydrogen peroxide solution then begins to drop into the chromic acid, and disengages oxygen until the pressure is restored. The flow from the Mariotte's bottle then stops, and the cycle begins again.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mrs. A. J. Pauley; a Mozambique Monkey (*Cercopithecus pygerythrus*, ♂) from East Africa, presented by Mr. E. Tudor Johnson; a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by Mr. J. H. Howden; a Coypu (*Myopotamus coypus*) from South America, presented by Mr. Sidney Grey: a Restless Cavy (*Cavia porcellus*) presented by Miss Druce; a Canadian Lynx (*Felis canadensis*); a Prairie Wolf (*Canis latrans*) from North America, presented by Mr. Henry Anger; two Mountain Ka-Kas (*Nestor notabilis*) from New Zealand, presented by the Hon. Walter Rothschild, M.P.; an Alexandrine Parrakeet (*Palaeornis alexandri*, ♀) from India, presented by Mr. A. Pam: a Beccari's Cassowary (*Casuarius beccarii*) from Vokan Island, Aru Islands; a Mauve-necked Cassowary (*Casuarius violicollis*) from Terangan Island, Aru Islands; a Salvadori's Cassowary (*Casuarius salvadori*), a Milne-Edwards Cassowary (*Casuarius edwardsi*) from North-west New Guinea, two Yellow-naped Cassowaries (*Casuarius occipitalis*) from the Island of Geelvink Bay, New Guinea; three Reeves's Terrapins (*Damonia reevesi*); three Black-headed Terrapins (*Damonia reevesi unicolor*) from China, deposited; two Red-breasted Mergansers (*Mergus serrator*, ♂ ♀), European; two Bahama Ducks (*Poecilonetta bahamensis*) from South America, nine Spotted-billed Ducks (*Anas poecilorhyncha*), a Bar-headed Goose (*Anser indicus*) from India, five Brent Geese (*Bernicla brenta*), European, purchased.

OUR ASTRONOMICAL COLUMN.

UNITED STATES NAVAL OBSERVATORY.—Prof. A. N. Skinner, one of the staff of this well-known observatory, contributes to *Science* (vol. ix., No. 210, pp. 1–16, January 6) a detailed history of the institution from its first inception to the present time. He divides the time into four periods, each characterised by some decisive change, both in the scope and administration of the department. In 1823, J. Quincey Adams,

the U.S. President, strongly urged the foundation of a depôt for the charts and instruments necessary for the navy; but it was not until 1830 that consent was given to this, when Lieut. Gouldsboro established one at Washington, the only astronomical equipment being a 30-inch focus transit. Three years later the contents were removed to a room about 14 feet square on Capitol Hill. Here the equipment was increased by a $3\frac{3}{4}$ in. transit, a Borda's circle, 3 ft. 6 in. focus achromatic, a portable transit, and sidereal clock. Up to this time the work of the institution entirely consisted of such astronomical observations as were necessary for the rating of chronometers. In 1838 a new epoch was entered upon by the instalment of Lieut. Gilliss, who at once improved the equipment and commenced systematic observations of the moon, eclipses and occultations, and also began the determination of right ascensions of standard stars. He soon reported to the Government that the housing of the instruments and charts was unsafe, and asked for better accommodation. It was not until 1842, however, that this request was acceded to, but in that year a Bill was passed voting 25,000 dollars for a new observatory. To prepare for it, Gillis visited all the European observatories and gave orders for the best instruments then available. The site selected was close to the Potomac River, and about 100 feet above the water.

In September 1844, the new observatory was ready for use with a fine equipment of first-class instruments; but, strange enough, the man who had evolved the whole of the arrangements, Lieut. Gillis, was not selected as superintendent, this post being given to Lieut. Maury, who occupied the position until 1861. During his incumbency the chronograph was introduced into the observatory, and it is of interest to read that for the use of a magnetic clock, fillet chronograph and cylinder chronograph, Dr. Locke was in 1849 paid the sum of 10,000 dollars. Maury's scheme of work was so wide that the reductions soon fell behind, and an enormous mass of work remained unpublished when he left in 1861. Gillis succeeded him, and again infused new life into the place. He resumed the meridian work, which had been almost neglected, and started to complete the reductions of previous observations. In June 1866, the observatory was relieved of a great part of its labour by the creation of the Hydrographic Office, which then took charge of all the charts, chronometers, sextants, &c. Later on, however, in 1883, most of this work came back to the institution. Daily time signals were originated in August 1865, by Prof. Harkness, and were transmitted by hand until 1879, when an automatic distributor was installed. The large 26-inch object-glass was received in 1873.

Magnetic observations had been started under Maury in 1845, but no progress was made until 1887, when a complete outfit was provided for obtaining continuous photographic records of all the magnetic elements.

In 1893 the observatory was again removed to its present site on Georgetown heights, 280 feet above the Potomac; it covers a circle having a radius of 1000 feet, and an area of about 70 acres. The principal work of the observatory is to carry forward a continuous series of meridian observations of the sun, moon, planets and ephemeris stars, which form the basis of the requisitions of the navy. Other work, however, has by no means been neglected, as is shown by the lengthy list of published observations and discoveries in the article. It is significant to notice that the magnetic observations have been entirely suspended at the new observatory since the summer of 1898, the results being vitiated by the electric roads in the vicinity.

USE OF TELEPHOTO LENS IN ASTRONOMY.—Dr. Rudolf Steinheil, of the famous German firm of opticians, contributes to the *British Journal of Photography* (vol. xlvi. p. 102) an article discussing, from experimental data, the extent to which the telephoto combination may be useful to astronomers. For stellar work he thinks it will be little used, as for delineating faint objects it is unfitted on account of its relatively low speed, and for successfully defining double stars, &c., it would necessarily have to be of large aperture. For the planets it is scarcely more fitted, the prolonged exposures necessary causing loss of definition owing to inaccuracies of following. The field of its use for astronomical purposes will probably thus only include the sun and moon. In the case of the moon the success will depend on the degree of magnification required, as if this is pushed too far the image becomes feeble, and the difficulties due to the moon's motion in declination, which are not remediable by using a driving-clock, render the result uncertain. With the sun, however, all the difficulties encountered with other objects disappear, as the light available is sufficient to allow of instantaneous exposures with the largest amplifications. This Dr. Steinheil thinks will be the only permanent use of the telephoto lens for astronomical purposes, and he instances cases in which photographs of sun-spots have been obtained measuring 7 mm. without sacrificing detail.

VELOCITY OF METEORS.—Prof. G. F. Fitzgerald writes in the *Astrophysical Journal* (vol. ix. p. 50, January 1899), suggesting the preparation for attempting to determine the velocity of the meteors during the next prominent showers. All that is required is an arrangement whereby a toothed wheel may be rotated in front of the camera lens during the exposure. The motion must be uniform, and we must know the rate of rotation and number of teeth on the wheel, and design these so that there may be two or more eclipses during the passage of the meteor across the field. Other methods of breaking up the image are given, such as an oscillatory motion of the lens or plate, or pointing the camera to a moving mirror; but in all these cases distortion of the star images would follow, and hence the advantage of the simple eclipsing arrangement.

It would probably be possible with some such arrangement as that suggested, to determine the meteor velocity with sufficient accuracy to show whether there is any sensible change due to the resistance of the atmosphere.

It is also evident that if two such cameras were employed at stations a considerable distance apart, and the same meteor caught by each, that the information given by the two would be extremely valuable.

THE FISHES OF THE NILE.

A MEMORANDUM regarding a proposed survey of the Nile, with the object of determining the species of fishes inhabiting its waters, has been drawn up by Dr. John Anderson, F.R.S., and is here printed in full, as it will interest all biologists. We are informed that the scheme, as detailed in the memorandum, has been sanctioned, and that Mr. W. Leonard S. Loat has been appointed superintendent. The only modification which has been made in the scheme, as detailed in the memorandum, affects the permanent use of a steam launch, as there was a practical difficulty in procuring one. The occasional use of a steam launch for trawling purposes will be available. This slight departure will in no way interfere with the efficiency of the survey.

Lord Cromer, whom Dr. Anderson approached on this subject in November last, has taken a most lively interest in the scheme throughout. The subjoined memorandum was drawn up at his request, and he has provided the funds necessary for the accomplishment of the Survey.

Our knowledge of the fishes of the Nile appears as yet to be very imperfect. It may be said to have taken its origin in 1750, when Hasselquist described thirteen species found in the deltaic area or in its immediate proximity. Since his time a number of distinguished men, *e.g.* Forskål, Geoffroy St.-Hilaire, Rüppell and others, have contributed by their observations personally carried out on the banks of the river to make its fishes more and more known.

By far the most important addition to our knowledge of the fishes of the Nile, after Hasselquist's day, was that made by Geoffroy St.-Hilaire in the "Description de l'Egypte," in which twenty-nine species were described and figured. Between 1829 and 1832, Rüppell published two valuable contributions to the subject. De Joannis, who accompanied an expedition to Luxor, somewhere about 1830-34, seems to have undertaken a careful investigation of the fishes of that locality during his brief visit. The value attached to his work rested largely on the fact that his descriptions, which were published in 1835, were illustrated by figures of each species drawn and coloured from life; moreover, he had not depended solely on the fishermen for his material, as not a few of the species were of no economic use and have not been rediscovered since. He described fourteen species in all, nine of which were new to science. His paper was supplemented by a list of all the known species of fishes inhabiting the Nile, including Rüppell's observations up to 1832; hence he enumerated fifty-three species.

In 1837, the third contribution of Rüppell appeared; but he was seemingly unaware of Joannis's researches at Luxor, and consequently he mentioned only fifty-five in his summary of the species then known to inhabit the river. The fishes collected by Russegger in Egypt enabled Heckel, in 1847, to raise the

number to sixty-seven species, excluding certain Barbels described by Rüppell from Lake Tzana and some other species of doubtful origin. This number, however, was considerably in excess of the reality, as many of Heckel's species were afterwards found to be synonyms. Sixty probably represented the number of the known species at that time (1847). Petherick, while in Egypt in 1861-63, made, at Dr. Günther's request, a collection of fishes for the British Museum. The specimens were obtained at Cairo, Khartum, and Gondokoro, and were described by Dr. Günther in an appendix to Petherick's "Travels," published in 1869. The collection contained eighteen new additions to the fauna, and raised the number of known species to eighty-two. It thus materially advanced our knowledge of the piscine fauna of the Nile; and as Dr. Günther not only figured eight species, but at the same time added a description of every form, his contribution has proved most useful.

Since 1869 the fishes of the Nile have been almost completely neglected. Sauvage, however, in 1880, added a new species from Lake Maryut; Pfeffer, in 1888, mentioned the species obtained by Stuhlmann in Egypt; and Mitchell, in 1895, brought to light and figured a new *Chromis* from Lake Menzaleh, and gave an account of the edible fishes of that lake. In 1896, Prof. Vaillant, in revising the Synodonts, pointed out the existence in the White Nile and at Khartum of two hitherto unrecognised forms.

At present, therefore, about ninety species of fishes are known to inhabit the river, but this number, considering the vast extent of its waterway and the very diverse physical conditions which characterise many parts of its course, cannot be considered as at all approaching finality.

The collections hitherto made from the Nile have principally been obtained from below the First Cataract; indeed Rüppel and Petherick are the only two collectors who had opportunities to investigate the river above Assuan. The former distinguished traveller and naturalist largely collected in Lower Egypt, and not a few of Petherick's specimens were from the same region. In Dr. Günther's account of this collection only six species were distinctly recorded as coming from Gondokoro, Khartum, and the White Nile, while thirteen, besides the foregoing six, species were stated to belong properly to the reach of the Nile above the Sixth Cataract.

In dealing with the distribution of fishes in the Nile, the use of the phrase Upper Nile, unless what is meant by the term is clearly defined, leads to endless confusion. Dr. Günther has made it quite evident in what sense he used the terms Lower and Upper Nile; but it is to be feared that the latter term has generally been used in a wider sense, and has included the river from Philæ southwards to the Lakes. While we possess a fragmentary knowledge of the species from Khartum southwards, the immense tract of the Nile from the First to the Sixth Cataract remains practically untouched.

The great mass of the forms known from below the First Cataract is largely made up of edible species, and a careful consideration of the literature bearing on this part of the Nile favours the supposition that the collections of fishes which have been formed in the past have been chiefly obtained by the assistance of the fishermen along the banks of the river and from the fish-markets of the country. However, in a great river like the Nile, unique in its annual inundations and in other characters, a much more thorough course of procedure than the foregoing is absolutely necessary in order to obtain an accurate conception of the true nature of its fauna.

Apart from the mere knowledge of how many species of fishes exist in the river, great economic questions come to the front when their life-history is studied. These, however, can never be usefully worked out until there exists on record a basis on which to work, in the form of a detailed description of each species accompanied, as far as practicable, by a figure.

The inundations of the Nile exercise a powerful influence on the distribution of the fishes contained in its waters, while, on the other hand, the cataracts retard their range. A multitude of questions of great interest bearing on the life-history of the species thus at once suggest themselves in view of the physical features encountered in this marvellous river.

Moreover, as within the next few years a change will be effected in the distribution of the Nile waters by the construction of the controlling-powers now in course of erection at Philæ and Assiut, and as other similar structures or dams are likely to follow toward the south, all of which are certain ultimately to limit more or less the range of certain species of fishes, it is much to be desired that, before any of these triumphs of the Department of Irrigation have been completed, we should be placed in possession of the main features and present condition of the piscine fauna of the great reaches of the river.

The present time seems also extremely opportune for the commencement of such an investigation, as the authorities of the Congo Free State have satisfactorily inaugurated a Survey of the Congo, and have already published some of the results. Were a corresponding Survey for the Nile entered upon by the Egyptian Government, and were the description of the species entrusted to Mr. G. A. Boulenger, F.R.S., who is describing the fishes of the Congo for the Congo Free State, and who is prepared to place his services at the disposal of the Egyptian Government free of all charge, the two surveys would mutually benefit each other, as the materials afforded by the one would throw light upon those of the other, many of the species of the two great rivers being closely allied. The results would doubtless be unique, and would form a lasting contribution to human knowledge, and, moreover, would be of great practical utility to both States.

The foregoing are a few of the grounds on which the proposed Survey is advocated.

Scope of the Survey.

It is recommended that some one who has had a zoological training should be appointed to superintend and carry out all the arrangements that it would be necessary to make for the formation of a representative collection of the fishes of the Nile, and who would be able likewise to discharge efficiently the other duties detailed in this memorandum. As it is very important that the form and life-colours of the different species should be accurately recorded by outline sketches, the Superintendent should be qualified to carry out such a work, because the information which such drawings would afford, if made by one who had a correct eye for colour, would be of great use to Mr. Boulenger when he came to describe the individual species. The highly-finished drawings for the illustration of the volume of "The Fishes of the Nile" would be made in London under Mr. Boulenger's personal supervision. A colloquial knowledge of Arabic would be of great advantage to the Superintendent, as it would enable him to obtain direct, from the fisher-folk on the banks of the river, much useful information on the subject of his investigations. Moreover, to properly discharge his various duties, the Superintendent should be a strong and healthy man.

An investigation of the entire river from the sea to Lado, and if possible through the *sudd* and rapids between Lado and Dufilé to its origin in the Albert Nyanza, should be kept in view as the ultimate aim of the Survey, which might be followed, later on, by similar researches into the fauna of the Nilotic lakes as a whole. Such a work is now proceeding on Lake Tanganyika, an intermittent effluent of the Congo, inaugurated by Mr. J. E. S. Moore, under the auspices of the Royal Society. Possibly when Mr. Moore has completed his work on that lake he may be able to direct his attention to Lake Kivu, and afterwards he might be in a position to cross the watershed to the Nile lakes and determine the character of their fauna as well, returning to civilisation by the Nile.

Although these are the lines on which a Survey of the Nile should be conducted to render it scientifically complete, it is suggested that the Survey should for the present be of a more limited character.

In the first instance, a series of stations should be selected along the river extending at intervals from the Delta, to Lado in the territory leased by the Egyptian Government to the Congo Free State, and as far to the south of this as possible. And it may be mentioned that were the Egyptian Government to inform the Secretary of State for the Congo Free State that an investigation into the fishes of the Nile was to be undertaken under its auspices, there is every reason to believe that the Secretary of State would issue orders for a collection of fishes to be formed by the Belgian officers at Lado and transmitted down the Nile to Cairo.

The following is a provisional list of the places recommended at which collections should be brought together, viz. Damietta, Lake Menzaleh, Rosetta, Lakes Burlus, Edku, and Maryut, Mahallet el Kebir, below the Barrage, above the Barrage, Cairo, Benisuef, Birket el Kurun (and two or three stations throughout the Fayum), Assiut, Luxor, Edfu, Assuan, Philæ, Korosko, Wádi Halfa, Akasheh, Dongola, Ambukol, Abu Hamed,

Berber, Kassala, Khartum, Sennaar, Fashoda, Sobat and Lado, and possibly Dufilé and Wadelai.

It is suggested that all necessary instructions for collecting fishes should be issued in the form of a circular in English and Arabic, and should be sent to some responsible official in each of the foregoing localities accompanied by a collecting-box and alcohol, to be supplied by the Trustees of the British Museum, with the name of the locality burned into the wooden case containing the metal box holding the alcohol, on which the name of the station also should be indelibly scratched or engraved. The selection of the officials to whom the collecting should be entrusted would be a matter for the Government to decide; but it is suggested that Commandants of Stations, officers of the Royal Army Medical Corps, and officials connected with the Irrigation Department would be the most likely to take the greatest interest in the work. I speak from experience, because not a few of these officials gave me invaluable aid in the formation of the collections on which the first volume of the "Zoology of Egypt" is based. In military stations, the black troops, when at leisure, are generally well pleased to assist in searching for living things, and were their successes rewarded by small pecuniary payments the results achieved by their agency might be considerable.

The services also of the fishermen along the river should be enlisted in the work, and were fair prices paid to them for the fishes they collected, and were they encouraged to procure as many kinds of fishes as possible, large and small, collections of considerable value would doubtless be forthcoming, and were they further instructed to net the very smallest fishes, in localities where there are backwaters, doubtless interesting and obscure species would be discovered.

The fishermen should also be utilised for obtaining the native names of the fishes throughout the different parts of the river, and it is suggested that each station should furnish a set of numbered specimens accompanied by a list giving the native name opposite to each number.

Should the Egyptian Government see its way to sanction this Survey, it is suggested that the officer in charge of the Museum of Natural History of the Medical School of Cairo should be entrusted with the reception of the collecting materials from the British Museum, with their distribution to the different collecting stations, with their reception when returned filled with fishes, and with the duty of forwarding them to London.

It is recommended that the distribution of the circulars and collecting-boxes should take place as soon as they are ready, and that they should be sent out to all the stations aforementioned, even to the most remote. In this way, many boxes would soon be returned filled, and, as they would at once be forwarded to London, the work of identifying the fishes might be proceeded with at once. By this plan, Mr. Boulenger would be placed in a position to offer valuable suggestions and to make known whenever the collections from a locality might require supplementing.

In not a few instances only the young of certain species might possibly be represented in a collection, or some of the specimens might be single examples of new or rare species which could only be satisfactorily made out by the aid of additional material. Mr. Boulenger having gone over the collection from one locality would thus be able, in returning the box for further material, to indicate clearly to the collector wherein his collection had been deficient. This could be done by the aid of an occasional figure of a fish when it was wanted, or even by the return of a specimen when more than one existed and more were required. It would also enable Mr. Boulenger to supply each station with a list of the species of fishes contained in each box, and by so doing contribute to stimulate the collectors to further exertions. Moreover, were preliminary lists of native and scientific names from a number of stations published at intervals and distributed among the stations, each collector would be in a position to judge of his relative success, especially in those cases in which the stations were situated on the same reach of the river. The native names of the fishes of the reach below the First Cataract are the same throughout the whole of its extent, whereas in many instances they differ materially from those in vogue between Berber and Lado. The reach from Philæ to Berber is so little known, in so far as its fishes are concerned, that preliminary lists from it would be invaluable, either in demonstrating uniformity or diversity of names in its own area, or as regards the reaches to the south and north of it.

Whilst the immediate distribution to the above-mentioned stations of instructions for collecting fishes, along with the necessary materials for so doing, is strongly advocated, it is equally desirable that in the beginning of the actual survey the attention of the officer in charge should be confined exclusively, in the first instance, to the river between Assuan and the sea. He should be constantly on the river at all seasons, and on his way down should visit the different stations, inspect the collections formed, satisfy himself that the specimens are properly preserved and that they are fairly representative. He should also particularly note the physical characters of the river at each station, find out as much as possible about the habits of the fishes, the depth at which they are found, the general character of the river-bed, the seasons in which the fishes breed, and the nature of their food. He should also satisfy himself that the native names have been correctly recorded in Arabic and rightly applied.

After the completion of the Survey from Assuan to the sea, the attention of the Superintendent should then be devoted to the reach of the river between Philæ and Berber, and after that has been attained he should proceed to investigate the interesting tract between the latter town and Lado.

To carry out his operations efficiently the Superintendent should be provided with a steam-launch, by means of which he would be placed in a position to use methods of fishing which it would be impossible to undertake by a sailing-boat. It would enable him to move freely up and down the reaches of the river which might require detailed investigation, and thus provide a means by which the Survey could be carried out in a thoroughly practical manner and with the least loss of time, as the nets at the disposal of the Superintendent might be constantly at work.

Other advantages of great importance would attend the use of a steam-launch in the way here advocated, as a cool airy room could be set apart for the storage of the specimens in alcohol, either in the course of preservation or finally preserved, and for the drying of the skins of fishes too large for conservation in alcohol. Moreover, the temperature of the contents of the boxes when the heat is great could, in such circumstances, be artificially reduced by simple means. The smooth joltless character of transit by water of boxes full of fishes recommends its adoption in preference to all other means; and, in connection with this, it may be mentioned that should it ever be necessary to send such boxes by railway train they should invariably be slung in complete shade. Transport by camels is out of the question.

The Superintendent should have the assistance of a native taxidermist to assist him in selecting the fishes as they are caught, in preparing and labelling them, and in changing the alcohol from time to time. His services would also be required in skinning the larger specimens.

On entering on the investigation of each new reach of the river from Assuan northwards, the Superintendent should secure the services, for a few days only, of three or four fishermen living on its banks and familiar with its fishing-grounds. Each party should be accompanied by its own boat and nets, so that when their services were no longer wanted the fishermen could easily return to their villages.

The Superintendent should be furnished with appropriate nets, among which should be an eight-foot beam trawl; and it is recommended that his equipment in fishing-gear should be much the same as that supplied to the officer entrusted with the survey of the Congo River.

This memorandum is accompanied by some instructions, drawn up by Mr. Boulenger, for the preservation of fishes.[1]

[1] As it is extremely desirable that any opportunity which may lend itself to the enlargement of our knowledge of the fauna of Egypt should be taken advantage of, it is therefore suggested that this Survey might, without much additional labour, do something towards making known the character of the Mammals found along the banks of the river, even as far as the margin of the desert. This might be accomplished were the Superintendent to have various kinds and sizes of appropriately baited traps set every evening when the launch was moored for the night along the river's bank, but not immediately in front of villages. They should be placed at wide intervals in zigzag lines reaching from the river to the desert; and likely situations for the presence of animal life, alternately on the two banks of the Nile, should be selected in determining where the launch is to remain for the night. Hares and animals of larger size should be prepared as skins, the skull and leg-bones of each specimen being left attached to the skin, the inside of which should be well smeared with arsenical soap. Specimens smaller than hares can be preserved in alcohol, but, as a rule, no mammal larger than an ordinary rat should be so treated, as the hair is apt to come off unless the spirit has been very frequently changed, which adds to the expense. As many skins, therefore, as possible should be prepared, even of

Cost of the Survey.

It is difficult to say what the annual cost of such a Survey as has been sketched would amount to. Were the Egyptian Government in a position to place a steam-launch at the disposal of the Survey, the cost of the working expenses, crew, and fuel, including the salary of the Superintendent and the pay of the taxidermist, should not exceed, under judicious management, more than 450*l.* to 500*l.* per annum for a period of three years.

The expenses would have been much greater had not the Director of the Natural History Departments of the British Museum undertaken to supply the necessary collecting-boxes, sixty in number, with alcohol to fill them. But apart from this there would be the initial cost of nets and other necessary apparatus, which may be put down at 20*l.*; but if the Superintendent were selected in England, his passage to and from Egypt would have to be met.

The cost of the transmission of the collecting-boxes from London to Cairo, as well as the cost of their return-carriage to London, would have to be borne by the Egyptian Government.

The cost of publication would be about 1500*l.* This calculation is based on the probably correct supposition that one hundred plates would suffice for the illustration in a satisfactory manner of the fishes of the Nile. The cost of each plate would be 12*l.*, so that 1200*l.* would be required for the illustration of the work, provided all the figures are uncoloured. The same number of plates in chromolithography would amount to nearly 2000*l.*

The printing of the text should not cost more than 300*l.*, so that were 1500*l.* set apart for the bringing out of a volume uniform with the "Reptiles and Batrachians of Egypt," but with uncoloured plates, the total cost of the undertaking would be met by a grant of 3000*l.* spread over a period of three years.

JOHN ANDERSON.

71 Harrington Gardens, London, January 12.

We, the undersigned, desire to express our general approval of the scheme detailed above for a Survey of the Nile, with the object of making known the species of fishes inhabiting its waters, and we beg to recommend it strongly to the favourable consideration of the Egyptian Government.

LISTER, President of the Royal Society of London.
A. GÜNTHER, President of the Linnean Society of London.
E. RAY LANKESTER, Director of the Natural History Departments, British Museum.
P. L. SCLATER, Secretary of the Zoological Society of London.

HUNTER AND THE SCIENCE OF SURGERY.[1]

IN accordance with the terms of a deed establishing the Hunterian Oration, we celebrate to-day John Hunter's name and fame. Born on February 14 in the year 1728 at Long Calderwood, a small estate his father farmed, some eight miles from Glasgow, he died on October 16, 1793, in his sixty-fifth year, celebrated alike as a great surgeon, a profound biologist, and a man of genius.

Here, in view of this noble presentment of Hunter by the foremost painter of his time, the orator is called upon to praise its foremost surgeon.

The picture was painted by Reynolds in 1785, when Hunter was fifty-seven years old, and as we look at it we perceive him in deep reverie, in one of those waking dreams to which he refers in his lectures. He has paused from writing in order to think out some problem, and, as he often said, it was a delight to him to think. As we dwell upon the features we cannot doubt that a sudden inspiration has flashed upon and gradually pervaded his mind, some great scientific truth or generalisation which he has grasped, and is pondering with intense satisfaction.

Buckle, in his "History of Civilisation," writes: "It sometimes seems as if Hunter's understanding were troubled by the grandeur of its own conceptions, and doubted the path it ought to take. Still, his powers were so extraordinary, that among the great masters of Organic Science he belongs to the same rank as Aristotle, Harvey, and Bichat, and is somewhat superior to Haller and Cuvier."

To appreciate, or even fully to comprehend, the labours of Hunter, one must strive to judge them from the standpoint of his time, for in this way only can we form a just conception of their splendid superiority.

On Hunter's early life and the many moot points it involves—his preliminary education, whether he was for a time a carpenter by trade, why he was not sent to Glasgow College like his brothers, or why in later life he spent some time at Oxford University without being in the least appreciative of the training he might there take advantage of—I do not purpose to dwell. William Hunter desired his brother John should be trained as a physician, and sent him to Oxford to obtain the necessary classical education, but during the short period he spent there he found himself quite unable to study Latin and Greek, and spoke afterwards rather contemptuously of the ancient learning.

Hunter's scientific career dates from his arrival in London in 1748, where, when twenty years of age, he joined his brother William's school as an ill-educated youth, new to all the amenities of life, brusque in manner and negligent in appearance, yet with a keen sense of physical enjoyment. As a pupil he showed a marvellous aptitude for anatomy, and soon became a successful teacher of it, but he always remained a learner in that book of nature which was ever open before him, and whose pages, until he died forty-five years later, he never ceased to turn, interpreting aright many of its obscurest passages.

In 1759, undermined in health by ten years of incessant toil, he obtained an appointment in the army and sailed with Keppel for Belleisle, and afterwards accompanied the expedition into Portugal. It was there that he studied the phases of inflammation and the treatment of gunshot wounds.

When he returned to London, with nothing but his half-pay to provide the wherewithal to live upon, and nothing but his genius to trust to for advancement, Hunter's life became one of untiring labour. He was elected a Fellow of the Royal Society when thirty-nine, a year later became surgeon to St. George's Hospital, and in 1776 was appointed Surgeon Extraordinary to the King.

In 1786 he was appointed Deputy Surgeon-General in the army, and three years later became Surgeon-General. He also published his work on Venereal Diseases in 1786, and the following year received the Copley Medal from the Royal Society on account of many valuable papers. His great work on the "Blood and Inflammation," however, still remained unfinished after thirty years of labour bestowed upon it, and was only published after his death.

At fifty years of age he had reached the zenith of his surgical career, having done more to improve the science of surgery than all the other surgeons of Europe had done before him.

On the death of Pott, Hunter became the chief surgical authority in London; his opinion was highly valued in difficult cases, and he acquired a lucrative practice. There is no doubt he was an admirable clinical teacher and a courageous operator, and although his systematic lectures on surgery were marred by a faulty delivery and occasional obscurity of style, they attracted all those who afterwards attained distinction amongst their contemporaries.

The evidence of Cline, Abernethy, Astley Cooper, Royer Collard, Billroth—surgeons indeed of every school—emphasise the excellence of these lectures on the Principles of Surgery, and it is still evident to the reader of to-day in the somewhat fragmentary record which has been preserved by Hunter's pupils.

Hunter was deficient in what we are pleased to call general culture, and doubtless he suffered in consequence. He read but little, and many of his discoveries had been anticipated by others, but when this was brought to his knowledge he abandoned any claim he might have advanced. It appeared to him of small consequence by whom a discovery was made if it only proved the stepping-stone to a higher and more complete knowledge. He was no mere collector of facts in order simply to augment their number. He thought too much attention could not be paid to facts so long as they helped to establish principles, and in the capacity for generalisation Hunter was pre-eminent. He had a great power of estimating what was worth doing, and how best to do it, his descriptions are graphic, and as an expositor of what he had to tell he is often unsurpassed.

the smaller mammals. Before specimens are placed in alcohol they should have the abdomen slit open to admit of the spirit having free access to the viscera. The date of capture, the character of the ground on which the animal has been found, the exact locality, and the sex of each individual should be entered in the day-book opposite to a number corresponding to the number attached to the specimen.

[1] Abstract of the Hunterian Oration delivered by Sir William MacCormac, Bart., K.C.V.O., President of the Royal College of Surgeons of England, at the College, on February 14.

He was attacked in 1789 by severe illness, and until his death four years later his life proved a very suffering one. Constant work and insufficient sleep doubtless shortened his days.

His death, sudden and tragic in its circumstances, happened in St. George's Hospital whilst he was demanding from somewhat hostile colleagues what he regarded as a just concession to his pupils.

In the first instance Hunter's work was biological, his range including both the animal and vegetable kingdoms, and the mineral kingdom as well, and to illustrate his investigations he became a collector. But he was chiefly and finally a surgeon, and to the development of surgery he brought all the knowledge and all the training which he had acquired in other branches of science.

He carries us beyond mere handicraft and detail into the region of general principles and law. The surgery of the Middle Ages was a trade, Ambroise Paré and Jean Louis Petit converted it into an art, John Hunter elevated it to the rank of a science.

Hunter's life and work inspired his successors with the spirit of observation, investigation and experiment. We see this exemplified in his great followers, Cline, Abernethy, Astley Cooper, Travers, Green, Brodie, Lawrence, and others since their time. They have been makers of English surgery, and each in turn has done much to raise it to that high standard which it has always maintained.

And now I may refer in detail, yet of necessity very shortly, to some part of Hunter's work in illustration of what I have just said, and show that his views, immensely ahead of his time, fall little short of the principles guiding the most modern surgeon.

I shall first allude to his observations on Animal Heat, which are of the greatest interest, especially when we remember the imperfect quality of the instrumental aid at his disposal; then say some words as to his opinions upon Injuries of the Head, and his never-to-be-forgotten work on Aneurism; I shall briefly review his study of Venereal Diseases; and, lastly, notice his great work on Inflammation and Gunshot Wounds—the last a subject which has always interested me. Nor could the account be in any sense considered complete without a reference to the past and present state of our great museum, itself an imperishable monument to John Hunter's memory.

In 1799, six years after Hunter's death, Parliament purchased his collection and subsequently handed it over in trust to the Royal College of Surgeons for the public advantage. Further grants of money were voted to the College to erect a proper building for preserving and extending "Master" Hunter's collection, and to build a theatre for the delivery of public lectures on anatomy and surgery.

The Hunterian Museum is a monument sufficient alone for the fame of any man. Hunter's aim was no less than to illustrate the whole question of life both in health and in disease. Nature's handiwork in all its manifold perfections is there clearly shown forth by the never-ceasing labour of this great intellect, and he did in the main compass his splendid aspirations.

Hunter rendered to his art and science greater service than any man had done before him, and his claim to our admiration rests not merely on what he did, but on what he suggested might be done.

One cannot but feel amazed at the multitude of the subjects which engaged his interest and attention, the greatness of his achievements, or the far-reaching influence of so many of his inquiries. His spirit survives in the energy of others who follow in his footsteps, and serves to stimulate every student of biological science.

His supreme endeavour was to study life in all its many-sided manifestations. This is the noblest form of study, and the most inexhaustible, yet the problem of life will remain a mystery transcending the power of human investigation or human imagination.

Billroth regarded Hunter as one of the greatest men the English nation has produced, and his work on Inflammation and Gunshot Wounds as the corner-stone of modern English and German surgery. "From Hunter's time to the present day," he says, "English surgery has had about it something noble, and nowhere, either in ancient or modern times, can the pattern be found of a grander scientific career."

Masters of our craft at epochs in surgical history have from time to time declared their art to be then so near perfection that further improvement was impossible.

May we not, nevertheless, hope and expect that surgery will still accomplish new triumphs and yet greater completeness? I am not of those who think there can be any finality in human progress; to believe so would, I consider, render life no longer worth living in its higher sense and greater aspirations. Rather let us consider ourselves as having but just crossed the threshold of the great temple of science, knowing only a small part of that which yet remains to be known.

Anæsthesia has rendered surgical procedures capable of a realisation which not even in dreams could we have supposed possible. It has permitted many new departures in surgery, made many operations feasible which had previously been condemned, and has proved a help of extreme value in the diagnosis of disease. As Oliver Wendell Holmes has said: "The fierce extremity of suffering has been steeped in the waters of forgetfulness, and the deepest furrow in the knotted brow of agony has been smoothed for ever."

Furthermore, one of the scientific descendants of Hunter, deeply imbued with his spirit, transcendently patient and painstaking in detail as was his master, as minute an observer of nature's ways, and as careful an experimenter, after much trying and much thinking, has realised, in the discovery of the methods of antiseptic surgery, a benefit to mankind which only surgeons can to the full appreciate. What was hazardous before is now rendered safe, what was accomplished with pain and suffering is now free from both. There is scarcely a limit to what might be said in praise of this great work. The name of Lister, like that of John Hunter, will stand forth in the records of scientific progress as one who has immeasurably benefited humanity, and as the author of the means whereby surgery has been mainly enabled to make that marvellous progress of which we are all so proud. This is recognised throughout the world, and were I not convinced that our science has fresh achievements in store, I should say that Lister had finally crowned the edifice whose corner-stone Hunter laid.

John Hunter's career has been presented to audiences in this theatre from almost every aspect, and his life and work have been reviewed by the greatest of his successors, some of whom have compelled our admiration by their eloquence and the beauty of the language in which they have expressed their thoughts. I do not expect to equal these, yet I would hope that my story, although "a twice told tale," has aroused in you some measure of sympathetic response. The study of Hunter's works is in itself a liberal education. They show his almost superhuman energy, the versatility of his genius, his extraordinary powers of observation, and beyond all these the absolute mastery of his will over bodily suffering. Of all the great minds which have illuminated the scientific world and guided its destinies, John Hunter's is the one which first directed surgery into the pathways of science, and dying left to surgeons a future in the memory of his past.

He is the one great man without whose aid it is impossible to imagine surgery all that it now is; we cannot take his influence away and yet retain all that we now possess. Our science might have spared some other workers, but it could not have become the science we know without John Hunter.

This great surgeon, one of the greatest men who ever practised surgery, has now long gone to his rest. Cut off in the midst of his glory, he died in harness. Yet, though he be gone, we may well apply to John Hunter what has been said of a pre-eminent statesman lately passed away: "The nation lives that has produced him, may yet produce others like him, and in the meantime it is rich in his memory, rich in his life, and rich above all in his animating and inspiring example."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 197th meeting of the University Junior Scientific Club was held in the large lecture-room of the museum on Wednesday, February 15, the President in the chair. There were present ninety members and twenty visitors. Prof. Odling delivered a lecture on chemical views in controversy about the year 1850. The following is an abstract of the lecture: To put back the clock is always a very difficult task, and to understand exactly the views of chemists of fifty years ago is extremely hard, as one must forget for the time being all that has been discovered since. In chemistry, as in most other

sciences, the tendency is to look forward and not backward; but it must not be forgotten that the future will be but a development of the present, as the present has been a development of the past. The evolution of chemistry has taken place along one continuous line, broken here and there by great fundamental discoveries, which have been rather apt at first to warp the line of development, and to make it a little one-sided. Thus the striking aptness of Dalton's atomic theory to explain the laws of chemical combination, which he had formulated, and the tables of proportional numbers deduced from them, attracted the attention of chemists to the determination of atomic weights. The importance of molecular weights, or as Prof. Odling preferred to call them unit weights, of compounds was not fully recognised till some half-century later, although Avogadro had pointed the way in his hypothesis put forward in 1811. In the forties Laurent and Gerhardt began to investigate unit weights, and laid the foundation of our present system. In this country Williamson and Brodie were the chief workers at the subject, and Prof. Odling described himself as their junior colleague to whose share much of the fighting fell. They had before them the problem of determining correct atomic weights for the elements, a problem which could only be solved after correct determinations of the unit weights of their compounds; and they considered that physical evidence as to unit weights must be confirmed by the chemical behaviour of substances. Hence the importance of Williamson's theory of etherification; for by showing that ether was not merely the oxide of a hydrocarbon radical, but that it was a combination of two hydrocarbon radicals with oxygen, he was able to deduce the unit weights of alcohol, ether, and other compounds compared with that of water, and to show that the carbon always combines in multiples of twelve, and oxygen in multiples of sixteen, and so these numbers must represent the real atomic weights. It was some years, however, before these new atomic weights, based on a true conception of unit weights, were generally accepted. The first text-book in which sixteen was used throughout as the atomic weight of oxygen being Prof. Odling's "Manual of Chemistry," published in 1861. Subsequently Newlands, from the revised atomic weights, suggested the periodic system of the elements, which was developed by Prof. Odling and Lothar Meyer, and completed by Mendeléeff. The chief work of chemists during the last quarter of a century might be briefly described as the investigation of the internal structure of the chemical molecule, and this, being dependent on an accurate knowledge of unit and atomic weights, is but the natural development of the most important work of the fifties—the correct determination of unit weights.

Mr. A. E. H. Love, F.R.S., Fellow of St. John's College, Cambridge, and University Lecturer in Mathematics, has been elected Sedleian Professor of Natural Philosophy in succession to the late Prof. Bartholomew Price.

CAMBRIDGE.—A Frank Smart Studentship in Botany, value 100*l.* a year for two or three years, will be vacant in June. Candidates must be B.A.s who have taken honours in Natural Science, and are of less than fourteen terms' standing. Names are to be sent to the Master of Gonville and Caius College by June 10.

Mr. A. W. Hill, of King's College, has been appointed Demonstrator of Botany.

Graces for the acceptance of the benefactions offered towards the establishment of a department of Agriculture will be submitted to the Senate on March 2.

A Salomons Scholarship of 70*l.* a year for three years will be vacant in 1900 at Caius College. Candidates will be examined in November 1899; they must be under nineteen, and must declare their intention of entering the engineering profession.

THE first of a series of occasional lectures at Bedford College will be given by Dr. W. J. Russell, F.R.S., on "How pictures can be taken on a photographic plate in the dark," to-morrow, February 24.

IN response to Mr. Balfour's recent appeal for the endowment of medical education and research, Sir Frederick Wills has forwarded to the treasurer of Guy's Hospital a donation of 5000*l.* to be used for the benefit of the medical school.

IT is remarked in *Science* that Harvard University some time ago established a class somewhat similar to the docents of the German University, though the lectureships are limited to a period not exceeding four months, and the University does not even collect such fees as may be charged. The first lectures under this system are now announced.

THE Glasgow University General Council have decided that the memorial to Principal Caird shall take the form of a window on the east side of the Bute Hall. The total cost is estimated at 900*l.*, of which 834*l.* have been subscribed. Mr. Archibald Craig, 156 St. Vincent Street, Glasgow, will be glad to receive contributions to make up the sum required to complete the memorial.

THE trustees of the Reid Trust for the education of women have decided to offer a scholarship at the London School of Medicine for Women, in memory of their co-trustee, the late Miss Bostock, of Penmaen, Glamorganshire. The value of the scholarship will be 60*l.* a year, tenable for two or four years, and awarded on the result of the preliminary scientific examination of the University of London. The Bostock scholar must read for the London medical degree. Further particulars may be obtained from the hon. secretary of the Reid Trust, Bedford College, York-place, W.

IN the House of Lords on Monday, Lord Norton asked the Lord President of the Council when the Education Bill would be introduced. In reply the Duke of Devonshire said that there appeared to be some misapprehension as to the character of his Bill. The Bills which he introduced last year were for the creation of a Board of Education and for the registration of teachers. Neither of those Bills could be described as an Education Bill. The measure which he should introduce would not, as far as he was aware, go beyond the scope of the Bill which he introduced last year. He hoped that next week or the following week he might be able to present the Bill again, and be able perhaps to name the day when the second reading would be taken.

THE sub-committee on Commercial Education, appointed by the London County Council in May 1897, have presented their report to the Technical Education Board. The committee have considered in detail the improvements desirable in elementary and secondary schools for pupils who propose to enter on a commercial career. Among the recommendations are the following:—

(1) That it is desirable that there should be in many of the public secondary day schools in London of the second grade departments devoting themselves primarily and avowedly to the preparation for commercial life of boys who will leave school at sixteen; that in such departments, while a good general education should be given, special attention should be devoted to modern languages in such a way as to turn out pupils able to speak and correspond fluently in at least two modern languages, to the teaching of arithmetic so as to secure perfect facility in the use of the metric system, and to ensuring a good general acquaintance with the commercial geography of foreign countries

(2) That it is desirable that there should be provided in London in at least one public secondary day school of the first grade a department devoting itself primarily and avowedly to the preparation for business life of boys leaving school at eighteen or nineteen; that the curriculum of such department should not lead up to a classical or mathematical career at the Universities, but should qualify its pupils either to enter the higher ranks of commercial life, or to pursue an advanced course of study in the economic and commercial faculty of the new London University, or in other institutions of higher commercial education.

(3) That it is desirable that full and express recognition should be given to higher commercial education in the reorganisation of London University, and that it be referred to the special subcommittee of the Board, dealing with the University, to consider whether it would not be wise to urge upon the Commissioners the establishment, from the first, of a separate faculty of economic and commercial science, the provision of endowed professorships in the various subjects of higher commercial education, and such arrangements as will facilitate and encourage those designed for or engaged in the higher ranks of business to take advantage of University teaching.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society (January).—Report on the theory of projective invariants: the chief contributions of a decade (by Prof. H. S. White), was read before Section A of the American Association for the Advancement of Science in August 1898. The starting-point is from th

publication of the second part of Gordan's "Vorlesungen über Invariantentheorie" in 1887. Gordan's famous theorem is on the finiteness of the form-system of one or more binary forms. After a slight introduction, the subject is discussed under six heads, viz. Mertens' demonstration and Hilbert's first proof of the theorem; Hilbert's general proof for forms in n variables; Deruyts' researches in enumeration of covariants of given characteristics; Hilbert's theorem upon syzygies of higher orders; miscellaneous topics; and the writer winds up with desiderata and remarks upon courses of instruction. It will be gathered from the above selection of headings that the report is likely to be useful to students. There are numerous references, which we hope are more accurate than the following footnote on the first page, which cites Sylvester's proof of the theorem; thus "Proc. Lond. Math. Soc., vol. 27 (1878), p. 11–13." There is a remarkable muddle here. Vol. xxvii. gives *Proceedings* of Session 1895–6, the *Proceedings* of 1878 appear partly in vol. ix. and partly in vol. x., and no reference to such communication occurs in the index to the first twenty volumes of the *Proceedings*.—Miss C. A. Scott discusses Holgate's translation of Reye's "Geometrie der Lage."—Prof. M. Bôcher gives an account of Burkhardt's "Funktionentheoretische Vorlesungen," vol. i., einführung in die Theorie der analytischen Functionen einer complexen Veränderlichen. The little work is said to be a useful introduction not merely to those parts of the theory which have been long classical, but also to the many other important developments of the last thirty years.—An extensive review of Darboux's "Leçons sur les Systèmes orthogonaux et les coordonnées Curvilignes," by Prof. E. O. Lovett, which follows, bristles with references to original memoirs.—Prof. J. Pierpont warmly commends the new Mathematical Encyclopædia, the success of which he regards as being mainly due to the genius, energy and courage of a single man, Felix Klein.—Errata, Notes (which are fuller than ever under Prof. Lovett's care), and new publications close the number.

Bollettino della Società Sismologica Italiana, vol. iv., 1898, No. 6.—Vesuvian notices (January–June 1898), by G. Mercalli. Describes the state of the volcano during each month, adding notes on the changes in the depth of the crater and the eccentric eruptive apparatus.—Correction [of an error in copying] in the report of the geodynamic observatory of Casamicciola (Ischia) on the Indian earthquake of June 12, 1897, by G. Grablovitz.—Reply to the same, by G. Agamennone.—Mode of utilising already exhausted *Dalle-Moile* dry piles: new "Guzzanti" pile, by C. Guzzanti.—Notices of earthquakes recorded in Italy (October 2–November 26, 1897), by G. Agamennone, the most important being the earthquakes of Porto Maurizio (October 12), the Marches (October 28), Tuscany (November 1–2), and Latium (November 6 and 13), and distant earthquakes of October 18–19, 20, 23, and November 11.

IN the *Journal of Botany* for January, Mr. Herbert Goss gives an account of the finding of *Orchis cruenta* in Cumberland, already alluded to in these columns.—In the number for February, Mr. G. S. West commences a list of the Alga flora of Cambridgeshire, a comparatively unworked ground. The list will comprise 409 species, 35 of them new to the British Isles, and 9 new to science, including a new *Bulbochaete* and a new *Oedogonium*.—Mr. H. C. Hart commences an account of a botanical excursion through the little-known West of Donegal.—Messrs. Britten and Boulger complete their first supplement (1893–1897) of their Biographical Index of British and Irish Botanists.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 9.—"On the Reflection of Kathode Rays." By A. A. Campbell Swinton. Communicated by Lord Kelvin, F.R.S.

The author has investigated the para-kathodic rays, so called by Prof. S. P. Thompson, which in a focus tube proceed from the front surface of the anti kathode, and cause the green fluorescence of the glass. By means of a tube in which these rays cast the shadow of a wire upon the opposite end of a tubular annex he has studied their magnetic deflection, and finds it to be in a similar direction to that of kathode rays. By means of another tube containing a small Faraday cylinder, into which some of the para-kathodic rays were caused to pass, he has determined that the para-kathodic rays carry negative charges. The author has previously shown that para-kathodic rays produced Röntgen rays, where they strike the glass; they also produce green fluorescence, hence he concludes that para-kathodic rays are simply reflected kathode rays.

The mechanical force exerted by these reflected kathode rays appears to be exceedingly small, and is insufficient to account for the inverse rotation of radiometer wheels, which, as described by the author in the *Phil. Mag.* for October 1898, occurs when the wheels are placed just outside the kathode stream. Indeed, all experiments designed to produce rotation by the impact of reflected kathode rays failed, and in some cases the wheels were found to rotate most persistently in a contrary direction, showing that whatever be the cause of such inverse rotation, it is more potent than the force of impact of the reflected rays.

The reflection of kathode rays is largely diffuse, but not altogether so; experiments with a polished concave platinum reflector, capable of rotation, gave under certain conditions distinct visual evidence of true specular reflection, with equal angles of incidence and reflection. In addition to the specularly reflected rays the anti-kathode reflector was also found under certain conditions to give off a well-defined beam of other rays normal to its surface, which caused fluorescence of the glass. The exact nature of these normal anti-kathode rays calls for further investigation.

The author has studied and quantitatively measured the electric charges carried by reflected kathode rays for different angles of incidence and reflection by means of special apparatus. A tube was constructed for this purpose, in which a polished flat platinum reflector could be set at different angles to the incident kathode rays This tube was fitted with a movable Faraday cylinder which was capable of rotation round the reflector, so that throughout a single plane the whole field traversed by the reflected kathode rays could be explored. The amount of negative charge imparted to the movable Faraday cylinder at different positions, and with different angles for the reflector, were measured both by a reflecting galvanometer and also by a quadrant electrometer. Many complete series of observations for different positions both of reflector and cylinder were made and all agree in showing that the field of reflected kathode rays is not uniform, but increases more or less gradually on both sides up to a maximum, which always occurs almost exactly at the point that makes the angle of reflection equal to that of incidence.

Further experiments show that the amount of charge carried by the reflected rays increases as the incidence is made more slanting, and that the electrification of the reflector itself, which is strongly negative when the incidence of the primary kathode rays is normal, gradually falls to zero as the incidence is made more slanting, until with very slanting incidence the electrification becomes slightly positive.

The author compares this result with that described by him in the *Roy. Soc. Proc.*, vol. lxiii pp. 434–435, viz. that kathode rays which strike the anti-kathode normally, are more efficient in producing Röntgen rays than those which impinge upon it very much on the slant.

The author points out that these results support the view that the Röntgen rays are actually due to the electric charges carried by the kathode ray particles being imparted to the anti-kathode.

Entomological Society, February 1.—Mr. George H. Verrall, President, in the chair.—Mr. Champion exhibited specimens of an interesting species of Fulgoridæ, *Atalanta auricoma*, Burm., recently received from British Honduras, and stated that he had found Lepidopterous larvæ in the white waxy matter attached to the body of an allied species, *Enchophora stellifer*, Burm., of which he exhibited a specimen, together with a larva taken from it. He also showed numerous specimens, and pointed out certain peculiarities, of both sexes of an undescribed species of *Apiomerus* (Family Reduviidæ) found by himself in Chiriqui.—Mr. Tutt exhibited on behalf of the Rev. G. H. Raynor a large series of *Spilosoma lubricipeda*, Linn., to show that the extreme aberrations of this species could be produced by inbreeding from comparatively normal forms. He then exhibited a number of closely allied forms of *Anthrocera*, received from M. Oberthür of Rennes, and comprising, among others, *A. medicaginis*, Dup., *A. medicaginis*, Bdv., *A. charon*, Dup., and *A. charon*, Bdv. The first two of these, as probably also the fourth, he referred to *medicaginis*, Bdv., considering them to be possibly forms of *Anthrocera lonicerea*; while the specimens of *A. charon*, Dup., were, he

stated, almost indistinguishable from typical *lonicerae*. Mr. Tutt next exhibited some remarkable colour-aberrations of *Anthrocera filipendulae*, captured by Mr. W. H. Harwood near Colchester.—Mr. A. H. Jones exhibited a fine specimen of *Sphaeria robertsi* attached to the larva of *Charagia virescens*.—Mr. Percy T. Lathy communicated "A monograph of the genus *Calisto*"; and the Rev. F. D. Morice, papers entitled "Illustrations of specific characters in the armature and ultimate ventral segments of *Andrena* ♂," and "Notes on *Andrena taraxaci*, Giraud."

Geological Society, February 1.—W. Whitaker, F.R.S., President, in the chair.—On radiolaria in chert from Chypon's Farm, Mullion District (Cornwall), by Dr. G. J. Hinde, F.R.S. This paper describes the discovery of a bed of chert on the mainland, similar to that already described from Mullion Island. The chert is interbedded with clay-slates, and it is a dark massive rock much traversed by quartz-veins; in some parts of it the radiolaria are preserved in an unusually perfect condition, showing their latticed structure and spines very distinctly. The radiolaria for the most part are casts only, without any definite bounding-walls, their outlines being indicated by the dark material of the groundmass, while the interior of the test has been infilled with clear silica, sometimes the cryptocrystalline variety, at others fibrous chalcedony. In the forms showing the structural details, these alone have been replaced by the opaque substance, and are thus clearly defined against the clear silica infilling the test. Eleven species are described, of which ten are new, while one has been previously recognised in the cherts of New South Wales. [At this point, Prof. Bonney took the chair.]—Gravel at Moreton-in-the-Marsh (Gloucestershire), by S. S. Buckman. The author describes certain gravels of Triassic débris and flints at Moreton-in-the-Marsh, with special reference to an upper bed wherein the fragments are mostly in a vertical position, some of them having their heavier ends uppermost. He theorises that the vertical materials were the droppings from melting ice floating down a large river.—On the occurrence of pebbles of schorl-rock from the south-west of England in the drift-deposits of southern and eastern England, by A. E. Salter. A set of twelve representative specimens, consisting essentially of quartz and tourmaline, have been looked over by Prof. Bonney, who informs the author that they consist mainly of felspathic grits, schorl-rock, &c., similar rocks to which occur in the south-west of England. The most westerly point at which the pebbles have been detected is on Great and Little Haldon Hills, 800 feet above Ordnance datum, where they are of larger size, more abundant, and coarser-grained than elsewhere. Thence they are traced to the north and south sides of the Thames Basin, and into East Anglia at Walton-on-the-Naze, Aldeburgh, &c. There is a general decrease in height in the deposit in which the pebbles occur, in passing from west to east, and the pebbles appear to have taken two main courses—one along a peneplain west to east from Dartmoor, the other from south-west to north-east across England. The pebbles are absent from the Weald and from the district around Bagshot, from the Hampshire Basin and its bounding hills (with the exception of the extreme south), and from the highest and presumably oldest gravels north of the Thames.

Linnean Society, February 2.—Dr. A. Günther, F.R.S., President, in the chair.—Mr. E. M. Holmes exhibited specimens of *Schimmelia oleifera*, a native of Venezuela, the wood of which yields an essential oil known in commerce as "West Indian Oil of Sandal-wood." The plant, hitherto undescribed, was found to belong to a new genus of *Rutaceae*, and has been named *Schimmelia*, after the German expert who distilled the oil, and, with considerable difficulty, procured flowering and fruiting specimens of the plant to enable its proper determination.—Prof. Howes exhibited three living specimens of the Lizard *Hatteria*, hatched from eggs which had been received from Prof. Dendy, of Canterbury College, Christchurch, New Zealand, with a view of working out the development of the skeleton. Prof. Howes described the circumstances under which they had been reared, for the first time in Europe, and made some observations on the rupture of the egg-shell. Further remarks were made by the President.—On behalf of Mr. J. Hamilton Leigh, there was exhibited an unskinned example of the Wild Cat, *Felis catus*, which had been trapped on January 31 in Argyllshire, and forwarded to London for preservation. It had all the characteristic features of *Felis catus*, and was of great size, weighing nearly eleven pounds. The President, in commenting upon the occurrence, expressed regret that the rarer Mammalia of Great Britain were daily becoming still more rare for want of that protection which might be accorded to them as well as to birds.—Mr. E. S. Salmon read a paper entitled "Notes on the genus *Nanomitrium*, Lindb." This genus had hitherto been regarded as cleistocarpous. Examination of fresh specimens of *N. tenerum* showed, however, that the capsules possessed a distinct zone of specialised cells—delicate, narrow, and transversely elongated—clearly marking off the upper part of the capsule as a lid. The author pointed out that the characters by which *Nanomitrium* had been separated from *Ephemerum* were insufficient, and considered that the former genus should be limited to *N. tenerum*, *N. Austini*, and *N. synoicum*, referring *N. megalosporum* (and perhaps also *N. aequinoctiale*) to *Ephemerum*. The essential character of the genus *Nanomitrium* was the presence of a zone of differentiated cells, by which a regular dehiscence is effected.—Mr. F. W. Stansfield read a paper "On the Production of Apospory by Environment in *Athyrium Filix-foemina*, var. *unconglomeratum*, an apparently barren Fern." This had been effected by cutting off parts of the immature fronds and allowing them to expand during eighteen months in an uniformly humid atmosphere. The result was the production in the ultimate divisions of a meristematic tissue which gave rise to (1) *gemmae* or bulbils, (2) *prothalli*, producing both apogamous buds and ordinary sexual axes of growth. One of the prothalli had been examined, and found to bear both archegonia and antheridia. On layering the primary fronds produced by apospory, it was found that these readily gave rise to fresh aposporous growths. The ease with which apospory was induced in the primary fronds, as compared with the extreme difficulty in the case of fronds from an older plant, was said to be characteristic of aposporous ferns in general, Mr. Stansfield having observed it in every case (eight in all) in which he had raised ferns by apospory. Assuming the truth of the "recapitulation" theory, he suggested that this fact indicated that apospory was an atavic trait in ferns.—Mr. H. M. Bernard gave an abstract of a paper entitled "Recent *Poritidae* and the position of the Family in the Madreporarian System." In attempting to solve the question as to the affinities of the *Poritidae*, the author adduced reasons for believing that the skeletal formation of *Porites* might be accounted for on the assumption that some early *Madreporaria* acquired the habit of budding before the skeleton was mature. The paper further dealt with all the recent genera which had from time to time been classed with *Porites*, and a revision of the Family was suggested.

Mathematical Society, February 9.—Lieut.-Colonel Cunningham, R.E., Vice-President, in the chair.—Mr. A. Berry communicated a note on a case of divisibility of a function of two variables by another function.—Mr. Love, F.R.S., read a paper on the scattering of electric waves by an insulating sphere. A complete solution is given of the problem of determining the disturbance of a train of plane polarised waves of electric force by a dielectric sphere of any size, and with any difference between the dielectric constants of the material of the sphere and the medium outside it. This solution verifies the first approximation for a very small sphere otherwise obtained by Lord Rayleigh, according to which the direction in which the disturbance in the scattered wave vanishes is at right angles to the direction of propagation of the incident waves. It also shows that in a second approximation, whatever the difference of dielectric constants may be, the direction in which the disturbance in the scattered wave vanishes is inclined at a slightly obtuse angle to the direction of propagation of the incident waves. Prof. Lamb, F.R.S., and Dr. J. Larmor, F.R.S., spoke on the subject. Mr. A. E. Western gave an account of his paper on groups of order p^3q, and also communicated a paper, by Dr. L. E. Dickson, entitled "The group of linear homogeneous substitutions on mq variables which is defined by a certain invariant." Mr. A. Young read a paper on the irreducible concomitants of any number of binary quartics.—The following were communicated in abstract: On a certain minimal surface and on a solution of $\nabla^2 V = 0$, by Mr. T. J. Bromwich. In the first part, the author investigates the condition that the plane $lx + my + nz = p$ should envelope a minimal surface. This is found to be $\frac{\partial^2 p}{\partial l^2} + \frac{\partial^2 q}{\partial m^2} + \frac{\partial^2 r}{\partial n^2} = 0$, a result previously given by Prof. Genese (*Quarterly Journal of Mathematics*, 1875). The known surfaces of the heliçoid and catenoid are proved to be deducible from this result. Comparing this with an expression for p in terms of l, m, n given

by Darboux ("Théorie des Surfaces"), we are led to a type of solution of $\nabla^2 V=0$, which seems to be related to the forms given by Prof. Forsyth in the *Messenger of Mathematics*, 1897. In the second part of the paper, Mr. Bromwich investigates this solution and allied forms.—On the complete system of differential covariants of a single Pfaffian expression, and of a set of Pfaffian expressions, by Mr. J. Brill; and the figure of Jacobi with respect to a linear system of hyperquadrics, by Prof. P. H. Schoute.

Royal Meteorological Society, February 15.—Mr. F. C. Bayard, President, in the chair.—Mr. E. Mawley read his annual report on the phenological observations, and stated that the weather of the past year, taken as a whole, had been throughout the British Isles very warm and dry. Wild plants blossomed much in advance of their average dates until about the end of March, but after that time until the close of the flowering season they were mostly late in coming into bloom. Favoured by the rains in May, the crop of hay was everywhere a remarkably heavy one, but the long drought which followed dried up the pastures and caused a scanty yield of roots. The dry season suited the cereals admirably, and especially the wheat, of which there was a very abundant crop. The yield of barley was nearly as exceptional, while that of oats, except in the north-east of England, and in Scotland, was also unusually good. There was a splendid crop of potatoes in Ireland and in parts of Scotland, but elsewhere the yield was on the whole moderate. Apples, pears and plums flowered abundantly, but adverse weather conditions, and the dry subsoil in the spring, caused an irregular "set" of fruit; so that in all parts of the kingdom these crops were, as a rule, below average. On the other hand, there were good crops of all the smaller fruits.—A paper by Prof. W. M. Davis, of Harvard University, U. S., on the circulation of the atmosphere, was read by the Secretary. The author said that although the circulation of the atmosphere is one of the earliest and one of the latest problems of meteorology, its treatment is ordinarily inadequate, inasmuch as the serious student seldom gains from the text-books in current use a comprehensive view of the great problem. After giving a brief historical development of the subject, the author went more particularly into the question of the outflowing polar winds, especially in the Antarctic regions. He called attention to the remarks made by Dr. Buchan at the conference on the "Scientific advantages of an Antarctic expedition," held at the Royal Society last year, and maintained that Prof. W. Ferrel's views on the circulation of the atmosphere, so far as they touch Antarctic winds and pressure, had been misunderstood by Dr. Buchan. Prof. Davis said that it must certainly be clear to every physical meteorologist, that the conventional circulation of the atmosphere, as ordinarily stated, was seriously incompetent, for the most striking features in the distribution of atmospheric pressure are not accounted for by it. As long as the effect of the winds in modifying the distribution of pressure is left out of consideration, no broad understanding of atmospheric processes can be reached.

CAMBRIDGE.

Philosophical Society, January 23.—Mr. J. Larmor, President, in the chair.—On the formation of clouds with ozone, by J. S. Townsend. The clouds which are formed when oxygen containing ozone is passed through a solution of potassium iodide, or sodium metabisulphite, are treated of in this paper. Experiments were described which showed that the formation of these clouds is due to the escape of iodine, or sulphur dioxide, from the solution. When oxygen containing small quantities of iodine vapour or sulphur dioxide is passed into a flask containing ozone a cloud is immediately formed. The cloud disappears when the gas in which it is suspended is dried, and reappears again in the presence of moisture.—(*a*) On detectors of radiant heat. (*b*) On the symbolic integration of of certain differential equations in quaternions, by H. C. Pocklington.—On the motion of a charged ion in a magnetic field, by Prof. J. J. Thomson. In this paper the motion of an ion moving through a gas dense enough for viscosity to make the velocity of the ion proportional to the force acting upon it is discussed. If H is the magnetic force, F the electric force, θ the angle between H and F, v_0 the velocity acquired by the ion under unit potential gradient, it is shown that the velocity of the ion at any point will have a component proportional to F along the line of electric force, a component proportional to $Hv_0F \sin\theta$ along the line at right angles to H and F, and a component proportional to $H^2v_0^2F \cos\theta$ along the line of magnetic force. The relative importance of the three components depends upon the value of Hv_0; if this is large, the ions follow the lines of magnetic force; if it is small, they follow the lines of electric force, while in intermediate cases they pursue a spiral path. Thus if we suppose the magnetic force to be constant, and consider two different kinds of ions moving with different speeds under unit potential gradient, the more quickly moving ions may travel along the lines of magnetic force, while the more slowly moving ones may travel along spirals. In the discharge of electricity through gases it has been found whenever the velocity of the ions has been measured that the velocity of the negative ion exceeds that of the positive. The author has shown in a paper recently communicated to the *Philosophical Magazine* that this difference between the velocities of the positive and negative ions will account for many of the remarkable differences between the appearances at the kathode and anode of a discharge tube. The results given in this paper show that it will also account for the difference between the behaviour of the negative glow and positive column in a magnetic field. Plücker showed that in strong magnetic fields the negative glow follows the lines of magnetic force; the positive column, on the other hand, does not do so, but pursues a more or less spiral path. This is what we should expect if the negative glow marks the path of rapidily moving negative ions, for which Hv_0 is large; in the positive column, on the other hand, we have to do with more slowly moving positive ions for which Hv_0 is not large enough to allow us to neglect the components of the velocity along F and at right angles to F and H in comparison with the velocity along H; when this is the case, the path of the ion is a spiral.

PARIS.

Academy of Sciences, February 13.—M. van Tieghem in the chair.—Notice on the life and work of the late Sir George Henry Richards, correspondent in the Section of Geography and Navigation, by M. Hatt.—On the heat of formation of anhydrous lime, starting from its elements, by M. Henri Moissan. The author has taken advantage of the purity of the calcium obtained by his methods to re-determine the heat of solution in water. The heat of formation of lime thus obtained, 145 calories, is greater than that of the oxides of sodium, potassium, and lithium; and direct experiment showed that this last metal could be obtained by heating together lithia and calcium in a vacuum.—On the mechanism of the thermal phenomena connected with the elasticity of solid bodies, animate or inanimate, by M. A. Chauveau.—On experimental typhoid infection in the dog, by MM. R. Lépine and B. Lyonnet. After injection of a virulent typhoid culture into the dog, the number of white corpuscles in the blood was modified, some bacilli were excreted by urine and bile, and the remaining bacilli appeared to be localised in the liver and spleen. After some days the blood serum acquired the agglutinating power, but the animal preserved every appearance of health, although for some weeks afterwards, living bacilli could be found in the liver and spleen. Contribution to the study of animal chlorophyll. The chlorophyll of the hepatic organ of Invertebrates, by MM. A. Dastre and N. Floresco. The hepatic chlorophyll is of alimentary origin; it is a vegetable chlorophyll which is fixed in a very persistent manner by the hepatic cells.—On an ancient fall of shooting-stars, by M. D. Eginitis. A historical study of the probable nature and identification of the asteroid swarm mentioned as occurring in the reign of Constantine. The date was probably the autumn of 752: the swarm identical with the Andromides.—Comparative measures of chemical intensity during the eclipse of the moon of December 27, 1898, by M. Th. Moreux. The results of the photometric measurements of luminous intensity, of chemical intensity, and of the theoretical luminous intensity are plotted graphically. The three curves do not coincide.—On a series of powers that are always divergent, by M. S. Pincherle. On the algebraic integrals of the equation of Riccati, by M. Léon Autonne.—On the elastic arch, by M. Georges Poisson.—On the propagation of a gradual elongation in an elastic wire, by M. L. de la Rive. Influence of magnetism upon the heat conductivity of iron, by M. Désiré Korda. It is found that the heat conductivity of soft iron decreases in the direction of the magnetic lines of force, but remains constant in the direction of equipotential lines, independently of the sense of the magnetising force.—On a particular case of electric oscillations produced by a Ruhm-

korff coil with open secondary circuit, and on a new method of measuring electric capacities, by MM. J. J. Borgman and A. A. Petrowsky. By the method given it is possible to measure capacities of a fraction of an electrostatic unit.—On the transformation of the X-rays by different substances, by M. Hurmuzescu.—The graphical method in the study of vowels, by M. Marage. The method employed was the photography of manometric flames, and diagrams are given for the curves of seven vowel sounds.—On phosphorescent strontium sulphide prepared by means of strontium carbonate and sulphur vapour, by M. J. R. Mourelo. Pure strontium carbonate gave a white, non phosphorescent sulphide, the best phosphorescence being obtained by using native strontianite.—Combinations obtained with fatty aldehydes and mercuric sulphate, by M. G. Denigès. Acetaldehyde gives a crystallised compound with mercuric sulphate, formaldehyde deposits mercurous sulphate only.—A new method for the qualitative and quantitative examination of the albuminoids, diastases, alkaloids, and leucoptomaines in urine, by M. Paul Chibret. An application of a solution of iodine in potassium iodide. Cocaine hydrochloride is used to obtain a standard turbidity.—On orthoxy-phenoxyacetone, by M. Charles Moureu. On a synthesis of hydroxylamine, by M. Ad. Jouve. The reaction between nitric oxide and hydrogen, in which ammonia and water are the chief products, can be shown under certain temperature conditions (115°-120°) to give a small quantity of hydroxylamine. The base was separated from the ammonium chloride simultaneously formed by means of alcohol, and identified both by its reactions and by analysis.—On the purity of the trimethylene prepared by the action of zinc powder and alcohol upon trimethylene bromide, by M. Gustavson. In reply to the criticisms of MM. Wolkoff and Menschutkin, it is shown that pure trimethylene may give rise with bromine to propylene bromide, and hence that the production of this latter substance is not a proof of the presence of propylene in the original gas.—On the tests for methyl alcohol in alcoholic liquids, by M. A. Trillat.—The fermentation of saccharides, by M. E. Dubourg.—On a mode of action of *Bacillus subtilis* in phenomena of devitrification, by Mlle. A. Fichtenholtz. *B. subtilis* was grown in nutrient solutions, in which no nitrogen was present except as potassium nitrate. The latter was converted into ammonia.—The yeasts as parasites, in their relations to Sorghum blight, by M. Radais.—Explanation of the formation of twins by mechanical action, by M. Fréd. Wallerant.—Variation of acuteness of vision with azimuth. Modification of the section of the cone by astigmatic accommodation, by M. André Broca.—Influence of slight traction upon the excitability of a nerve, by M. G. Weiss.—On the development of *Convoluta Roscoffensis*, by M. Jivoin Georgévitch.—On three new Orthonectida, parasites of the Annelids; and the hermaphrodism of one of them (*Staecharthrum Giardi*), by MM. Maurice Caullery and Felix Mesnil. On the seeds of *Allanblackia floribunda*, and on the Bouandja butter which it contains, by M. Edouard Heckel.—Modifications in the primary bark of the Dicotyledons, by M. Eberhardt.—On the structure of the Briançonnais, by M. P. Termier.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 23.

ROYAL SOCIETY, at 4.30.—On the Order of Appearance of Chemical Substances at different Stellar Temperatures; Sir J. N. Lockyer, F.R.S.—The Efficiency of Man, or Economic Coefficient of the Human Machine: Dr. Marcet, F.R.S., and R. B. Floris.—Some Experiments bearing on the Theory of Voltaic Action: J. Brown.—Deposition of Barium Sulphate as a Cementing Material of Sandstone: Dr. F. Clowes.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

FRIDAY, FEBRUARY 24.

ROYAL INSTITUTION, at 9.—Coherers: Prof. Oliver Lodge, F.R.S.

PHYSICAL SOCIETY, at 5.—The Joule-Thomson Thermal Effect: E. F. J. Love.—(1) A Study of an Apparatus for the Determination of the Rate of Diffusion of Solids dissolved in Liquids; (2) Note on the Source of Energy in Diffusive Convection; Albert Griffiths.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Loss of Heat from Buildings: R. Gordon Mackay.

SATURDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S.

ESSEX FIELD CLUB (at Technical Institute, Stratford), at 6.30.—British Well-Worms (*Phreoryctes*), with special reference to a Unique Specimen from Chelmsford: Rev. Hilderic Friend.—On a Neolithic "Fascine" Lake Settlement at Skitts Hill, Braintree, Essex: Rev. J. W. Kenworthy.—Some Illustrations of Pond-Life: D. J. Scourfield.

MONDAY, FEBRUARY 27.

SOCIETY OF ARTS, at 8.—Cycle Construction and Design: Archibald Sharp.

IMPERIAL INSTITUTE, at 8.30.—The Right and Wrong Routes to the Klondyke Goldfields: F. P. Rathbone.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Travels and Researches in Rhodesia: Dr. H. Schlichter.

INSTITUTE OF ACTUARIES, at 5.30.—Some Notes on Life Assurance in Greater Britain, particularly with reference to the Work and Development of the Native Offices: Arthur Wyndham Tarn.

TUESDAY, FEBRUARY 28.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

SOCIETY OF ARTS (Foreign and Colonial Section), at 4.30.—Persian Trade Routes: A. Hotz.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Improvements in Dioptric Apparatus for Lighthouses: W. T. Douglass and J. A. Purves.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Apparatus for Animated Photography: Birt Acres.

WEDNESDAY, MARCH 1.

SOCIETY OF ARTS, at 8.—Leadless Glazes: Wilton P. Rix.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, MARCH 2.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Perturbations of the Leonids: Dr. G. J. Stoney, F.R.S., and Dr. Downing, F.R.S.—On Flapping Flight of Aeroplanes: Prof. M. F. Fitzgerald.—On Hydrogen Peroxide as the Active Agent in producing Pictures on a Photographic Plate in the Dark: Dr. Russell, F.R.S.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

LINNEAN SOCIETY, at 8.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Wireless Telegraphy: G. Marconi.

CHEMICAL SOCIETY, at 8.—Bromomethylfurfuraldehyde: H. J. H. Fenton and Mildred Gostling.—The Action of Metallic Thiocyanates on certain Substituted Carbamic and Oxamic Chlorides, and a New Method for the Production of Thiobiurets: Dr Augustus Edward Dixon.—Ethylic $\beta\beta$-Dimethylpropane Tetracarboxylate: W. Trevor Lawrence. The Action of Alkyl Iodides on Hydroxylamine: Prof. Wyndham R. Dunstan, F.R.S., and Ernest Goulding.

FRIDAY, MARCH 3.

QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, MARCH 4.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S.

CONTENTS.

THURSDAY, MARCH 2, 1899.

ELECTRICITY AND RAILWAYS.

Applications of Electricity to Railway Working. By W. E. Langdon. Pp. xvi + 331. (London: E. and F. N. Spon, Ltd., 1897.)

IN this book the author shows that he is well acquainted with the subject on which he writes, and that his knowledge is of a thoroughly practical character; we can, therefore, recommend it not merely to those who are professionally engaged with railway working, but also to that portion of the public who take an interest in the various methods that are adopted for securing their safety, and administering to their comfort, when they are travelling by rail.

The book opens with a chapter "on the construction of a line of telegraph," in which cogent reasons are advanced why, in the making of a new railway, the company ought to face the initial expense of constructing good, rather than cheap, telegraph lines; and the results of a "penny wise and pound foolish" policy are pointed out.

The language used in this chapter—indeed throughout the book—recalls the telegraph engineer of thirty years ago in that force and expressiveness, rather than elegance or exactness, are the result aimed at. The older engineer, for example, speaks of the "railway metals" when he means the iron rails, "metalling a road" when he means laying down stones, and the "metal" of an insulator when he is referring to the porcelain cup, and not, as a person might imagine, to the iron stalk of the insulator. Sentences like—"Iron arms formed of L-iron . . . are less costly than the tubular arm, but fall short of the degree of strength which the latter enjoy," the portion of the arm earth-wired is practically covered, &c.," "a 9-feet sleeper will cut three stay blocks, say each 36 inches by, &c.," invest iron and old railway sleepers with an activity that certainly has the effect of giving life to the book. The "D.V. insulator," we are told, is a "double Varley," and so we realise that it is not a pious reference to the wishes of Providence; but how many of the average readers will be able to guess what such crisp expressions as "G.I. wire" and "G.P. wire" stand for?

Chapters ii., iii., and iv. deal with "surveying," "posts and wires," and "telegraph instruments and batteries" respectively. The use of the telephone to replace telegraphic signalling is dealt with, the practicability of employing the same line wire for the block bell and the telephone, on not very busy sections of the railway, is pointed out, and the methods of running several circuits on the same telegraph poles so that there shall be little mutual induction between them are described. The author doubts the advantage of replacing Leclanché cells with dry cells, but quotes the results of tests which show that of the two the dry cell polarises less rapidly than the Leclanché cell when each is joined up in series with a resistance of 100 ohms, or "short-circuited" through a resistance of 100 ohms, as the author incorrectly calls it.

Much is told us in Chapter v., and told us well, about "block signalling," of which there are three methods in actual use, viz. the *positive*, the *affirmative*, and the *permissive*. With the first the signal is left indicating "line clear," except when a train is actually on the section in advance; with the second the signal is normally left "line blocked," and it is only on information being telegraphed forward by the signaller that a train desires to enter a section, and on the signaller in advance telegraphing back his consent, that the semaphore arm is lowered. With the third system, two, or more, trains going in the same direction are allowed on one section at the same time, but the rear trains are warned that there are other trains in advance. This last system, which can hardly be called a block system at all, is, however, only employed under exceptional circumstances, such as in the working of station-yards, to enable trains to be brought to a stand at their respective platforms, for interchange of traffic, or for connection with other trains.

The *affirmative* system is the one generally employed with the railways in this country, but on the Metropolitan Railway it is found necessary to resort to the *positive* system, in consequence of the large number of trains; so that the semaphore-arm being up indicates that there is actually a train on the section ahead.

We may take this opportunity of noticing, although Mr. Langdon does not refer to the matter in his book, that the behaviour of the ordinary railway passenger furnishes a striking example of the absence of powers of observation that characterises the average person. A train is at rest, say, at the platform of a Metropolitan Railway station, and the danger signal is obviously up, yet the passengers tear down the stairs, and rush frantically along the line of carriages only to wait, panting for breath, until the train starts. Again, we wonder how many copies have been sold of the photograph of "the Flying Dutchman going at sixty miles an hour," and how few are the purchasers who have noticed that in this photograph the signal is against the train, so that it must have been at rest when the photograph was taken. Or, again, how many persons who obtained season tickets for the Inventions Exhibition remarked that the train stamped, in gold, on the cover of the ticket was running neither on the "up" nor on the "down" pair of rails, but on one of *each* pair, so that there was a single odd rail left on each side of the train for some mysterious and unknown use.

The animated character of the instruments in this chapter is almost suggestive of Rudyard Kipling, for Mr. Langdon says that the tongue of a relay "obtains its magnetic life from a permanent magnet H," and that the indicating portion of an apparatus is locked "in the position last afforded it by the current."

The block instruments devised by Preece, Pryce and Ferreira, Spagnoletti, Tyer, Webb and Thompson, and others, are fully dealt with in Chapters v. and vi., while Chapter vii. brings us to "automatic block signalling" with which the passage of a train works the signal electrically or electro-pneumatically. This subject has made practically no progress in this country, for while Hall's automatic system, requiring only a comparatively small battery for each section of the line, is largely used on the United States railways, it is only on the Liverpool Overhead Electric Railway, where there is plenty of electric

power available, that automatic block signalling has found a footing in Great Britain. To work Timmis' "long-pull electromagnet" used on this line "the energy required is 5 amperes at a pressure of 40 volts (200 watts)"—at least so says the author of this book, making the same sort of confusion between current, energy and power as characterises "Article 12 of the Programme of the International Competitive Trials of Accumulators for Road Traction," which has just been published, and which states: "Besides an ammeter measuring the total quantity of electricity supplied to and from the batteries as a whole, an energy meter (watt-meter) . . . will measure the quantities of energy absorbed by and supplied to each of them."

Unlike automatic block signalling, the interlocking of the mechanical devices, and of the electric and mechanical devices, connected with signalling and shunting, has received much attention in Great Britain during the past twenty-nine years, the earliest attempt in this direction having been made in 1870 by the author himself in conjunction with Mr. Preece, and a large number of illustrations connected with this part of the subject renders the study of Chapter viii. instructive. Some of the illustrations, however, are drawn on too small a scale, and are not well enough executed to enable the reader to clearly understand all the details.

In the next chapter signal repeaters, light indicators, train indicators, lightning protectors, &c., are dealt with. A signal repeater is a device for indicating whether the motion of the arm of a semaphore, which is out of sight, corresponds correctly with the motion given by a signalman to the handle in his box, while a light indicator informs him whether the lamp on a semaphore post has gone out, or has become dim. The action of the latter depends on the *difference* in the expansion, by heat, of a tube of *brass* and of a rod of *steel* inside it; this, however, is not clearly explained, and from the description it would appear as if the action would take place just as well if the tube and the rod were of the same material. These indicating devices are found to be of great use, says the author, "at heavily signalled termini."

"Electric station lighting" and "electric train lighting" come next, and the author mentions that while arc-lighting of goods-yards-sidings is now much used, since it effects economy in capital, men, material and time in loading trucks, it was originally introduced in the Nine Elms yard mainly to stop the robbery which the absence of efficient lighting encouraged, and that the cost of its installation there has been largely defrayed by the diminution of the loss through theft that has resulted.

The author, like so many practical men, talks about "the volts and current," although doubtless he would not say "the feet and weight of a girder" when he meant "the length and weight," nor would he speak of "the pounds of the main boilers," although he does not hesitate to write "the volts of the main dynamos." Since the *generic* name *current* is regularly employed, without reference to any particular unit of current, why should not the expression "*pressure*," "*potential difference*," "*P.D.*," or some other *generic* name, be similarly used. "Current and pressure" if you like, or "amperes and volts" if preferred; but, great as may be our respect for the lineman on a railway, or for the switchboard attendant in an electric light station, it is not compulsory for us to form our technical language by slavishly copying his "current and volts."

To produce a Board of Trade unit inclusive of all charges excepting those for land, taxes and depreciation of buildings, costs the Midland Railway Company (to whom Mr. Langdon is the electrical engineer) from 2·3*d.* at the Birmingham Central Station to 3·5*d.* at the Leeds Hunslet Station. These amounts, although much higher than the corresponding sums at a London large electric light-generating station, are fair, in view of the short time that artificial lighting, even in the winter, is required in a railway goods yard, or in offices which close at 5.30 p.m.

The subject of lighting railway carriages interests every one—or ought to. But the public have for many years tolerated the lamp being placed at the middle of the roof of the compartment of a railway carriage instead of at the back of the reader, and no expression of feeling was manifested when the fixing of penny-in-the-slot accumulators and reading-lamps in the carriages on the Metropolitan District Railway suggested the principle that the Company did not undertake to light even the first class compartments in return for the sum paid for the passenger's ticket.

The author suggests—and we think rightly—whether "it might not yet be advisable to attach to each train a vehicle equipped for the double duty" of lighting and heating, "having for its primary source of power an oil engine."

The short Chapter xii. on "intercommunication in trains in motion" we may pass over—for the author has recently dealt with that subject at length in a paper read before the Institution of Electrical Engineers—and we come to the last, on the "administration of the engineering branch." In this the author suggests (probably unintentionally) the explanation of the special literary style adopted in his book, for he says:

> "When we write a letter the conventionalities of society demand a degree of courtesy which is readily excused, and which would seem absurd in a telegram. It is not clear why it should be so; why a letter—especially a business letter—should not be just as acceptable if couched in the same concise terms considered so proper for telegraphic correspondence."

We conclude as we commenced by expressing the opinion that, in spite of minor blemishes such as we have referred to, Mr. Langdon's book is distinctly good on the whole. For of what consequence are a few antiquities of expression, and how easy is it to be critical *now*, and to suggest improvements in the work of men of the older school which can be made *to-day*, when we are revelling amidst a wealth of electric meters, ammeters, voltmeters, coulomb-meters, watt-meters, energy meters, potentiometers, &c., and are enjoying the luxury of the labour-saving appliances with which technical colleges are equipped? Will, however, the young electrical engineer of to-day, with all this vast collection of electrical appliances at his command, succeed in making so deep an impress on electro-technical science as did men like Mr. Langdon thirty years *ago*, and will a practical electrical

treatise written thirty years *hence* by the young electrician of to-day be as much up to date *then* as is "The Application of Electricity to Railway Working" in 1899? "P. D."

OCTONIONS.

Octonions; a Development of Clifford's Bi-quaternions. By Alex. McAulay, M.A. Pp. xiv + 253. (Cambridge: University Press, 1898.)

FROM a purely formal point of view, apart from any question of geometrical or physical application, the mathematical method known as quaternions may be described as a system of shorthand for dealing with the algebra of certain complex numbers.

Let i, j, k be three independent entities which obey the relations

$$ij = -ji = k,\ jk = -kj = i,\ ki = -ik = j,\quad i^2 = j^2 = k^2 = -1 \quad \ldots \text{(i.)}$$

and those derived from them; and let w, x, y, z be any four real numbers. Then the totality of complex numbers of the form

$$w + xi + yj + zk$$

evidently constitute a self-contained system; in the sense that the result of combining two or more such numbers by addition or multiplication is another number of the system. Moreover, it may be easily shown that the result of dividing any number of the system by

$$w + xi + yj + zk$$

is a definite number of the system unless w, x, y and z are all zero.

Quaternion analysis is a method of shorthand, and an extremely compendious one, for dealing with this system of complex numbers.

Hamilton himself considered, under the name of biquaternions, an extension of this particular algebra in which each real number w, . . . , is replaced by

$$w_1 + w_2\sqrt{-1},\ \ldots,$$

where w_1, w_2, . . . , are real numbers.

This is equivalent to dealing with the self-contained system

$$w_1 + x_1 i + y_1 j + z_1 k + w_2\omega + x_2 i\omega + y_2 j\omega + z_2 k\omega \quad \ldots \text{(A)}$$

in which i, j, k, ω obey the relations (i.) and the further relations

$$i\omega = \omega i,\ j\omega = \omega j,\ k\omega = \omega k,\quad \omega^2 = -1 \quad \ldots \text{(ii.)}$$

Clifford introduced two distinct extensions of the algebra of quaternions. In each of them the complex number is of the form (A). In one, i, j, k, ω obey the relations (i.) and (ii.), except that the last equation of (ii.) is replaced by

$$\omega^2 = 1.$$

In the other, i, j, k, ω again obey the relations (i.) and (ii.) with

$$\omega^2 = 0$$

in the place of the last equation of (ii.). To both of these algebras Clifford gave the name biquaternions.

It may be noticed that the formal algebra of Hamilton's biquaternions is quite independent of the supposition that ω is the $\sqrt{-1}$ of ordinary algebra; it depends purely on the laws implied by (i.) and (ii.).

The three algebras thus obtained are the only distinct extensions of the algebra of quaternions that result from introducing a single new unit or entity which is permutable with i, j and k, while its square is an ordinary real number.

What one may call the geometrical counterpart of quaternion algebra is the geometry of rotation round a fixed point, and the parallelism between the algebraical and the geometrical theory is complete. To the general complex number in the algebra corresponds the most general operation on rotations round the point, viz. the operation which will change any one such rotation into any other. There are also geometrical theories standing in the same relation to the three extended algebras, each containing as a part, as it should do, the theory of rotation round a fixed point.

It was, in fact, from the geometrical side that Clifford approached the subject in his published writings. His point of view may be presented briefly as follows.

A velocity system in space (*i.e.* the mode in which a rigid body is moving at any instant) is completely specified by an axis AB, the magnitude a of the velocity of rotation about AB and the magnitude V of the velocity of translation along AB. From the doubly-infinite set of operations which will change any velocity system given by AB, a, V into any other given by A′B′, a', V′, a particular one may be chosen as follows. Let CD be the common perpendicular to AB and A′B′; and let $a' = pa$, and $V' = qV$. There is a definite twist with CD for its axis which will bring AB to A′B′, and at the same time the direction of V along AB to agreement with the direction of V′ along A′B′. The operation which changes the one velocity system into the other may be made up of (i.) this twist, (ii.) an operation which merely changes the magnitude of the rotation velocity in the ratio p to 1, (iii.) an operation which changes the magnitude of the translation velocity in the ratio q to 1; and these three may be carried out in any order. The operation involves in its specification eight distinct numbers, since a twist involves six.

Having thus obtained a definite view of the operation which changes one velocity system into another, Clifford goes on to discuss the laws according to which such operations combine. These of necessity depend on the nature of the space in which the motions take place. He only glances very briefly at the case of ordinary Euclidean space, and develops the theory, so far as he carries it, for elliptic space. He shows, in effect, that the formal laws involved for elliptic space are those of the extended quaternion algebra, for which

$$\omega^2 = 1.$$

The carrying out of the theory for hyperbolic space, in which case the formal laws are those of the extended quaternion algebra where

$$\omega^2 = -1,$$

still awaits treatment.

Prof. McAulay's book deals with the theory for ordinary space, which is found to correspond to the remaining case, viz.

$$\omega^2 = 0.$$

An octonion (the author gives reasons for preferring this word to biquaternion) is in fact, from the algebraical

point of view, a complex number of the form (A), in which i, j, k, ω obey the relations (i.) and (ii.) with $\omega^2 = 0$ in the place of $\omega^2 = -1$. From the geometrical point of view it may be regarded as the ratio of two velocity systems in ordinary space.

The shorthand system expounded by the author for dealing with this algebra follows closely the lines of that used in quaternions, but is, as might be expected, considerably more complicated. Since ω is permutable with i, j, and k, the octonian (A) may be written in the form

$$w_1 + x_1 i + y_1 j + z_1 k + \omega(w_2 + x_2 i + y_2 j + z_2 k),$$
$$\text{or, } q_1 + \omega q_2,$$

where q_1 and q_2 are two quaternions. The phraseology and notation adopted turn largely on this division of an octonion into two parts. An octonion for which both w_1 and w_2 are zero is called a motor. Like a vector in quaternions it may be regarded either as an operation or as an object to be operated on. From the latter point of view it is, when interpreted kinematically, a velocity-system. Corresponding to the linear and vector function of a vector in quaternions, there is here the linear and motor function of a motor; *i.e.* from the algebraical standpoint a matrix of six rows and columns. A self-conjugate function is defined somewhat as in quaternions, but it is not the case that a symmetric matrix corresponds to a self-conjugate function. The least convincing part of the book is, perhaps, that in which the author extends to octonions some of the conceptions of the *Ausdehnungslehre*. The inner product of five and of six motors are defined so that the first is a motor and the other a number; and it is apparently implied that the inner product of any given number of motors is a definite quantity of some kind. No expressions, however, for such a product are given except in the two special cases mentioned; and the idea involved does not seem to be utilised in the chapter of applications with which the book ends. This chapter consists of more or less well-known results investigated or expressed in the octonion notation; and it inevitably suggests the question: Is the method one which will lend itself to the purposes of research? It is of course too soon to say. In the meantime it is clear that octonions cannot be used, any more than quaternions, for the purposes of numerical calculations; and that the newer method cannot, from the very nature of the case, claim the beauty and symmetry that are such distinguishing marks of quaternion analysis.

W. Burnside.

THE ALPINE GUIDE.

Ball's Alpine Guide: the Western Alps. New edition, reconstructed and revised on behalf of the Alpine Club by W. A. B. Coolidge. Pp. xlix + 612. (London: Longmans, Green, and Co., 1898.)

The issue of the first volume of the new edition of "Ball's Alpine Guide" will be welcomed by all those who seek their relaxation in the Alps. Though it is nearly ten years since this enterprise was taken in hand by the Alpine Club as a fitting memorial to John Ball, its first President, the character of the revision is so thorough, and the incorporated matter has been so judiciously assimilated with the original, that any delay will be readily forgiven. The task of producing this edition has fallen to Mr. W. A. B. Coolidge; and that this has been to him a labour of love, carried out on the lines laid down by Ball, there can be no question. What distinguished "Ball's Guide" from all others, and rendered it pre-eminent, was that in it one had, as it were, a companion leading one through the finest scenery in Europe, a man of culture with a true feeling for the mountains, and an accomplished naturalist who found an especial fascination in topography and plant distribution. Nor has Mr. Coolidge fallen from that high plane. With a skill so admirable has he interwoven in the original fabric the results of Alpine exploration of the last quarter of a century, that we have a book absolutely up to date and yet without any indication of patchwork or composite origin. And for this he merits the sincere gratitude of mountain lovers.

The present volume deals with the Western Alps, *i.e.* the Maritime, Cottian (including Dauphiné) and Graian Alps, the range of Mont Blanc, the Central and Eastern Pennines. It is divided into six chapters, dealing with the six main areas or ranges, and these fall into a varying number of sections (there are twenty-one in all) treating of the districts. As examples of the districts may be mentioned the Pelvoux, Grand Paradis, Grand Combin, and Monte Rosa districts. Each district has its introduction, in which especially matters relating to the topography of the district in question are lucidly set forth. "Ball's Guide" being written by an Alpine wanderer for wanderers, the subject-matter is unfolded in the form of routes, *i.e* intersecting lines selected with a view to serve as a scaffolding for the descriptive matter. In this way some ten or twelve routes serve to exhaust a district. All matter off the line of journey in any route—as, for instance, an account of a peak or some adjacent valley—is enclosed in heavy square brackets. This system works out very well in practice, as indeed it should, seeing that about one-third of the book consists of matter thus enclosed. For the convenience of such as are not wanderers, but who remain for days or weeks at some centre, at least one "route" in each district is largely occupied with notices of the various expeditions that may be conveniently made from its chief centre. And in this matter Mr. Coolidge has kept pace with present-day requirements, for in addition to Zermatt and Chamonix we find the newer centres of Arolla, Val d'Isère, Cogne, La Bérarde, &c., thus treated. In this way the country in each district is very minutely worked out, but concisely and without tedious elaboration. Mr. Coolidge exercises a wise selection in the peaks which he describes: he gives detail when detail is desirable; whilst subordinate peaks, unless of topographical or special mountaineering importance, are merely named. Though there is no pretence to the full detail of a "Climbers' Guide," practically all interesting routes are sketched in or suggested. There is no scamping of out-of-the-way spots. Take, for instance, Grand Paradis District, Route E., Cogne to Pont Canavese by the Val Soana. Here, within the limits of two pages, we find mentioned all the essential features of a tract of country that it could not take less than three weeks to explore, and these stated briefly, clearly and correctly. Yet it is doubtful

whether half-a-dozen travellers stray into this area in the course of a season.

Though the book is good throughout, some regions seem to lend themselves more conveniently to topographical treatment than others. Or it may be that a subtle attractiveness in some countries has not been without its influence upon both author and editor. If it be permissible to discriminate, we would mention the chapters devoted to the Dauphiné Alps and to the Graians as masterpieces of topographical description, as models of what they should be. At the same time, an occasional omission must be noted. A good deal of space is devoted to the Grivola, but no hint is given of the wonderful nature of the ascent by the south-west face from Valsavaranche—an ascent which cannot fail to impress the traveller as one of the most remarkable in the Alps. And there is the less excuse for this omission, as space is wasted by a wholly uncalled for foot-note (p. 307), in which Mr. Coolidge explains that Ball is too enthusiastic in his description of this mountain, as seen from the eastern edge of the Trajo glacier. "Remarkably stumpy and unimpressive" are Mr. Coolidge's words—to us, after several visits to the spot, the very reverse seems the truth, and we take our stand with Ball.

In conclusion, there are numerous ways in which Mr. Coolidge earns our gratitude. Every altitude quoted is given both in feet and metres, a luxury which the climber will not fail to appreciate. Then there is an exhaustive bibliography, and the index is more than satisfactory. Nor has he been unmindful of the historical associations which cling to the mountains. Old traditions, topographical fables, the early ascents of the Fathers of Mountaineering—all these and many kindred subjects are genially yet critically unfolded in the pages of this book. It is hardly necessary to say that blood-curdling stories of Alpine misadventure find no place here. The introduction of six new district maps, on a scale 1 in 250,000, specially prepared for the work, also demands recognition. These are unusually clear and easy to use, whilst the circumstances under which they have been prepared are a sufficient guarantee as to their accuracy. The botanical notes, which occur constantly throughout the pages of the original, have been retained, and additions have been made to them. It may be mentioned that the "general introduction" is not included with this volume; it is to be issued independently in the immediate future.

F. W. O.

OUR BOOK SHELF.

Psychology in the School-room. By T. F. G. Dexter and A. H. Garlick. Pp. viii + 413. (London: Longmans, Green, and Co., 1898.)

The authors describe their book in the preface as an "attempt to apply the laws of mental and moral science to school work." If we can hardly look upon the result of this attempt as an unqualified success, it is because Messrs. Dexter and Garlick are by no means as well acquainted with the principles of "mental and moral science" as they evidently are with the practical requirements of the school-room. A psychologist who comes to them solely for practical hints as to methods of teaching, will find much that is suggestive in their treatment of their subject; but we should hardly recommend a teacher who wishes to acquire a sound, even if elementary, knowledge of psychology to take them as his guides. It would, indeed, hardly be going too far to say that "Psychology in the School-room" is a treatise written by persons who know little psychology for readers who know less. Partly this is due to mere defects of information. Thus the account of the "muscular sense," on p. 63 ff., must have been written in ignorance of the important researches, fully described in so accessible a work as James's "Principles of Psychology," which have profoundly modified our estimate of the psychological significance of these once-vaunted sensations. The account of space-perception given in the same chapter, again totally ignores the "nativistic" doctrine of such eminent authorities as Hering, Stumpf, and James. It may be, as the authors say (p. 81), that "distance is inferred, not seen"; but, in the present state of the controversy, it is a gross piece of presumption to make the statement without explaining that it is denied by many of the best modern authorities. Still more unfortunate is the habitual inaccuracy and vagueness of the writers' terminology. They tell us, for instance, repeatedly, that "vibrations" of ether, air, &c., are transmitted to the brain, and there "interpreted" by the mind as sensations of colour, sound, &c. This is, of course, fiction, and fiction of the most misleading kind; as we are never aware of the "vibrations" at all, it is nonsense to call the sensations, to which they serve as physical antecedents, "interpretations" of them. The way in which, in the chapter on "judgment," judgment is said on one and the same page to be a "higher" process than conception, and to be already involved in conception, the very similar way in which in the following chapter definition is spoken of, first, as having to do with "words," then as concerned with "things," then once more as of "names," the double treatment of what are essentially the same facts, once in Chapter viii., under the head of "Association," and again in Chapter xiii., under the title of "Apperception," are a few instances, from among many, of the authors' inability to form consistent views of their subject, and to express those views with precision. Such looseness of thought and language is intolerable in any work, however elementary, that professes to describe the principles of a science.

A. E. T.

Physical Chemistry for Beginners. By Ch. M. van Deventer. Translated by R. A. Lehfeldt. Pp. xvi + 146. (London: Arnold.)

In a preface written by Prof. J. H. van 't Hoff the object of this work is stated to be the presentation of physical chemistry to medical students in such a fashion as to avoid putting their physical and mathematical accomplishments to too severe a proof. The fundamental laws of combination are dealt with concisely and clearly, prominence being given to the experimental basis for each law. Chemical formulæ, however, are introduced so abruptly into the second chapter, that it is clearly the author's intention that the remarks given are to be considered as supplementary only, either to lectures or a text-book of systematic chemistry. The succeeding chapters deal with the behaviour of gases, thermochemistry, solutions, photo-chemistry, and the periodic system. In the chapter on the properties of gases, *normal* temperature and pressure are defined as 15° C. and 760 mm. of mercury, although later on in the same chapter the more usual 0° C. and 760 mm. are frequently used. The definition of atomic weight as obtainable from the experimental results is very clearly stated, an uncommon feature in an elementary text-book. The section dealing with thermo-chemistry occupies one-half

of the whole book. It contains a full account of thermochemical notation, a selection of the more important data, and an elementary discussion of the law of maximum work. Chemical equilibrium and dissociation are also dealt with, the treatment being non-mathematical, and bearing evidence of the influence of van 't Hoff. The book as a whole forms an admirable introduction to general chemistry; the student who has mastered its contents will have nothing to unlearn, and will be able to proceed at once to the larger text-books of Ostwald and van 't Hoff.

Elementary Hydrostatics. By Charles Morgan, M.A., R.N. Pp. 106. (London: Rivingtons, 1899.)

This small text-book contains practically a condensed account of all the leading points in hydrostatics which are usually included in an elementary course, accompanied by an unusually large number of exercises. It makes no attempt at exhaustive treatment, and is rather intended for those studying the subject with tutorial aid. We are sorry to see that the author has gone on the old lines in the dual interpretation of "pressure" as thrust, and also as thrust per unit area, and we should have liked to have seen the notion of "whole pressure" kept in the background, and greater emphasis laid on the use of the formula for the same in obtaining the resultant thrust on a *plane* area. The familiar figure of the air-condenser with the valves resting in their usual impossible upside-down position is here once more reproduced. We like the author's simple treatment of centres of pressure as being instructive and useful to beginners, despite the objections that mathematicians may raise against its validity. For the points which we have criticised, the fault probably lies not so much with the author as with the examinations for which it is his purpose to prepare candidates, and we think that the book will be of great value to all students whose limited time prevents their reading a large treatise. G. H. B.

The Valley of Light.—Studies with Pen and Pencil in the Vaudois Valleys of Piedmont. By W. Basil Worsfold. (London: Macmillan and Co, Ltd., 1899.)

An author adds to his difficulties by writing a book in the form of letters, especially when he desires to combine instruction with entertainment. Mr. Worsfold has not been more successful than others in overcoming these, and we are not surprised that, as he admits, his fair correspondent found his epistles "not very entertaining." In fact he does not add much to our knowledge of this district. Like his predecessors, he is almost silent on its geology and botany, and devotes himself to the history of the past persecutions and present fortunes of the Waldenses. The former subject is an interesting but hardly a novel one; for it is treated pretty fully in Beattie's "Waldenses" and Gilly's "Narrative." The Waldenses, in fact, have already been the cause of not a few books, if we include those in other tongues than our own, and Mr. Worsfold's does little more than add to their number. We doubt, indeed, whether the best authorities would agree with him in tracing the Waldenses back to early Christian settlements in these valleys, or in the date (twelfth century) which he assigns to the Nobla Leçon. Nothing of special importance seems to have happened in the Waldensian valleys during the last half-century. Their worthy inhabitants have prospered fairly and maintained their high character, but this, though satisfactory, affords but few opportunities to an author. In short, Mr. Worsfold's book has no scientific value, for even the illustrations are poor; and it displays little historical research or originality.

LETTERS TO THE EDITOR.

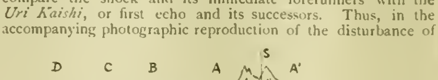
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Earthquake Precursors.

In Nature, February 16 (p. 368), under the title of "Earthquake Echoes," I described the more or less rhythmical series of fading resultants which are seen to succeed many large earthquakes. These earthquake followers, the first of which may sometimes represent the *Uri Kaishi*, or return shaking of the Japanese, are repeated in groups with a decreasing amplitude, an increasing period, and with a smoother and smoother contour. The last of the series may be so small that it is usually difficult to say with certainty when a large earthquake has ceased to exist. As pointed out by Mr. R. D. Oldham, it seems quite possible that certain of the terminal vibrations may have travelled round the world in a direction opposite to that taken by the larger members of the series. The movements to which I now refer are the procession of vibrational groups which run before the main disturbance, with the smaller of which, under the name of preliminary tremors, we are already more or less familiar. These precursors have in several respects characteristics which are exactly the opposite to those of the earthquake followers. They have a definite commencement, and with large earthquakes group after group usually increases suddenly in amplitude and period.

Another feature of the precursors is that, whilst group after group may grow larger, they become more and more larger featured in their contours. The very first of the preliminary tremors have no *frétillements*, or have lost whatever they may have had, whilst those which follow carry serrations which are well marked. This observation, together with that of the growth in amplitude, suggests the idea that the main features of each group of precursors starting from a common origin have reached an observing station by different routes; the first have come along Knott's path of least time, whilst the latter, culminating in the shock, may have travelled along paths continually approximating to that of a free surface-wave.

Now and again, we see in groups of preliminary tremors a likeness in contour and arrangement of what is to follow; but likenesses of this description are perhaps best seen when we compare the shock and its immediate forerunners with the *Uri Kaishi*, or first echo and its successors. Thus, in the accompanying photographic reproduction of the disturbance of



June 29, 1898, if we take S S as a line of symmetry, which lines are not uncommon in seismograms, the shock 1 in the group A is preceded by groups of waves 2, 3, 4 and 5, which are not unlike the echoes 1', 2', 3', 4' and 5'; whilst in the precursors B and C, 1, 2, 3 are not unlike 1, 2, 3. In group D all likenesses are lost. Our knowledge of the very first preliminary tremors like D is less than that of those which follow. Near to an origin they may have a duration of from one or two up to ten or twenty seconds, and their period has been recorded at from 1/5 to 1/20 of a second. When they are preceded by a sound-wave, we have evidence of a very much higher frequency. If these vibrations have travelled long distances and through our earth, most records indicate a period of three or four seconds. Records from Rome have shown periods of less than half a second, but even these are probably much too large. My own records indicate only a slight switching at the end of a light elastic boom or a very rapid to-and-fro motion of the boom relatively to its steady-point. Until a steady-point seismograph with extremely light multiplying indices like that of Vicentini, or some other special form of apparatus, has been employed as a recorder, our knowledge of this end of the seismic spectrum is not likely to increase.

The last points connected with the earthquake precursors are

the intervals of time which elapse between the arrival of the first tremor and the largest wave or waves corresponding to the originating impulse and the duration of the very first series of preliminary tremors. As measured on seismograms for disturbances which have originated at different distances from the Isle of Wight observing station, these two intervals are given in the following table :—

Origin.	Distance in degrees.	First P.T. to max. motion in minutes.	Duration of first group of P.T.s in minutes.
Iceland	17	4 or 5	1·4
Greece	22	7	7·0
Tashkent ...	48	15	9·0
Hayti	62	30	13·0
Japan	84	47	8·5
Borneo	112	55	6·0

These figures are too few in number to be used as a foundation for any certain conclusions, but they may possibly indicate results to be sought for in future records. With regard to the first set of intervals, we know that for distances up to 8° from an origin the time by which tremors outrace the main movement may be reckoned by seconds. Adding this fact to our list, it seems that here we have a table which indicates that as an earthquake travels the tremors outrace the large waves at a very slow rate on the first part of its journey; but as its distance from the origin increases, this rate increases. This goes on until a point between 48° and 62° distant from the origin has been reached, after which the rate at which the large movements are left behind decreases.

One explanation for this is to suppose that the first precursors came through the earth with an average velocity which observation shows to increase approximately with the square root of the average depth of the chord joining the centrum and the observing station, whilst the large waves travelled round the surface. An objection to this view is that observations exist which show the large waves have apparently travelled over paths varying between 20° and 110°, at rates which rather than being constant have increased from 2·1 to 3·3 km. per second.

The velocities giving this comparatively slight difference were, however, determined on the assumption that the times at which various earthquakes originated were known, and there is, therefore, a possibility that they may be apparent rather than real.

Also it must be remarked, as pointed out by Dr. C. G. Knott, that if we regard the speed of propagation of the large waves as depending on a coefficient of elasticity, mainly distortional and not appreciably influenced by change of pressure and density, it is quite conceivable that the large waves should also pursue a brachistochronic path through our earth. The question then arises whether these larger movements would be left further and further behind their precursors in the manner indicated.

When we come to our second set of intervals which indicate the duration of the first preliminary tremors before they are eclipsed by groups of vibrations which usually grow in size and appear from their periods to be distortional, we see that up to a point about 62° from an origin these figures increase, but beyond that point they grow less.

What we have to explain in addition to this fact is that of the practical continuity and growth in magnitude of what very often forms a long and continuous series of preliminary motions. As I have already stated, their very appearance indicates that they have travelled on different paths. The first have followed a path entirely through our earth, whilst the successors may have travelled shorter and shorter distances through the earth to meet a crust through which they have completed their journey to the observing station. The first followed Knott's brachistrochronic path, or that of least time, whilst the successors took paths the latter parts of which were along arcs of increasing length. The result of this would be that at an observing station vibrations would arrive in series, each group corresponding to an originating impulse. The last of the rabble would be the series representing the main shock which, although it sent waves on brachistochronic paths, may in part have travelled as a surface undulation through the crust.

To illustrate this hypothesis I here reproduce a sketch given to me by Dr. C. G. Knott, showing the probable form of wave-fronts and paths of compressional vibrations passing through our earth.

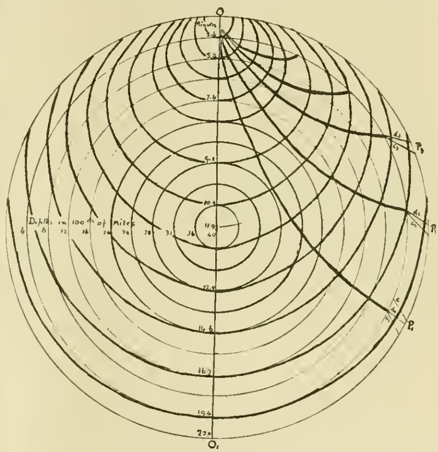
The assumption on which this has been drawn is that the square of the speed of the movements is a linear function of the depth, which closely corresponds, as already indicated, with observation.

The result at which Knott arrives indicates that the square of the speed increases at 0·9 per cent. per mile of descent in the earth, the formula being [1]

$$v^2 = 2·9 + ·026\,d \text{ in mile second units.}$$

With an initial velocity of 1·7 miles per second, the velocities at depths of 400, 800, 1200 . . . 4000 miles become 3·7, 4·9, 5·8, 6·7, 7·4, 8·1, 8·7, 9·3, 9·8, and 10·3 miles per second. The times taken for wave-fronts to reach the positions shown are indicated in the sketch; the time taken to pass through the earth being 22 minutes.

I assume that when a wave has passed from its origin beyond the region vaguely referred to as the crust of our earth, it then spreads in all directions through a mass in which there is only an extremely gradual change in elasticity and density with regard to its centre. All wave-paths, however, before they emerge at the surface, encounter at varying obliquities the under-surface of this crust. For purposes of illustration, we will assume this



region of abrupt change to lie on the 400-mile circle. The path p_1 meets this surface nearly at right angles, whilst $p_2\,p_3$ meet it at decreasing angles less than right angles. After each of these incidences a condensational wave will be refracted and split up into condensational and distortional rays. Now it will be observed that these two waves, which I will call c and d, will have different distances to travel before actual emergence, which distances will increase from p_1 towards p_3. At any station P_1 the first arrival will be c, but as this will be eclipsed on the arrival of d, its duration will always be short, and unless the originating shocks are well separated, seismograms, as we know them, can never show more than one set of condensational tremors.

At some point, like p_3, the duration of the preliminary tremors should reach a maximum, but from this point on towards the origin this quantity will decrease, if only on account of the fact that the velocity along the brachistrochronic ray differs less and less from that of the distortional wave within the crust. Such a view may possibly explain not only the short duration of the first precursors, but also the rise and fall in the values of our last column.

The growth in amplitude of the groups of tremors may be due to the fact that they are usually the outcome of originating impulses which increase in intensity until they culminate in a violent shock.

[1] See *Scottish Geographical Magazine* for January 1899.

As a simple illustration of earthquake radiation, we may imagine a disturbance to originate at O as a single impulse, the resulting vibrations spreading in all directions through the earth, and in all directions over its surface. The former of these may be regarded as elastic vibrations, whilst the latter have the character of surface undulations influenced by gravity. At any station P_1 the first arrivals would be preliminary tremors, chiefly compressional in character. These would be suddenly eclipsed by vibrations, probably distortional, originating by refraction beneath the crust in the vicinity of P_1. The first of them we should expect to find serrated, whilst their followers emerging between P_1 and P_2 would be smoother in outline and larger in amplitude. The last and largest members of the series would be those which have travelled practically as free surface-waves through the crust. The result of such radiation as exhibited on a seismogram would be to show true preliminary tremors, suddenly followed by a series of larger waves, which would gradually grow in size. If at the origin there were several impulses, then these latter precursors would arrive in groups. An alternative hypothesis is to assume that all the vibrations recorded at a station P arrived along their peculiar brachistochronic paths through the earth, an important fact supporting which, is that up to the present we have not with any certainty identified waves which may have reached P passing outwards from O round our world in opposite directions. Although it is not likely that I shall be able, in the tremor-haunted, damp, dark stable where I work, to catch the waves which have taken the longest route to my observing station, that there are such surface undulations radiating in all directions from an epifocal area there is but little doubt. Near to an origin you see the little waves come rolling down a street, whilst at distances of 300 miles the ground swell may be so heavy that I and many others have been seized with nausea. What proportion of seismic energy escapes round the surface of our earth, as compared with that which passes through the same, I do not know; but if the experiment were made, I should not be surprised to find that at the time of large earthquakes, mountains swayed like the masts of ships on a slowly heaving ocean.

All that has here been suggested is clearly very far from being above criticism. It indicates a want of knowledge respecting the researches of the elastician, whilst the facts are few. Although the observations may be characterised by their poverty, I often see in the rough-headed mobs of earthquake precursors rhythmical repetition; and I trust that, if my story of their creation and long duration is not the true one, it may at least induce others to attempt better hypotheses. JOHN MILNE.

The Orbit of Witt DQ.

THE extreme eccentricity of the orbit of Witt's planet suggests some interesting speculations. Assuming the aphelion and perihelion distances in terms of the earth's mean distance are respectively 1·79 and 1·12, the planet approaches the sun in 322 days, a distance of sixty-one million miles, an average of 200,000 miles a day.

Practically this may be considered as a fall, during the half-revolution, of this distance. Now if the planet were a perfectly plastic body, and we knew all its elements, it would be perfectly possible to determine the deforming forces acting on it during the passage. It is evident that the force of gravity acting on the forward point of the syzygial axis would always be in excess of that on the rear, and in consequence that the tendency would be to continually lengthen that axis in a proportion referable to the squares of the distances fallen. On the other hand the force of internal gravitation towards its own centre would always tend to restore the sphericity, and the result would be that a body starting as a sphere from aphelion would find the syzygial axis prolonged and its shape deformed into an increasingly prolate spheroid, till on its arrival at perihelion and its commencement to retreat the reverse phenomenon would occur, and the planet on its return become again a sphere.

Now, of course, we have no reason to suspect that DQ is a plastic body, and the comparative insignificance of its size, would, were it to be composed of matter of equal rigidity with ordinary rocks on the surface of the earth, enable it to successfully resist these deforming influences. We may, however, imagine a case where the strains would be sufficient to break up an ordinarily rigid body, if the eccentricity exceeded a certain amount, and the consequent differential action of gravity became sufficiently great.

A hypothetical planet moving in an orbit of high eccentricity, for instance, between Mars and Jupiter might, so long as it continued plastic, preserve its condition as a single coherent body. If, however, it were cooled to an extent sufficient to become enveloped by a rigid crust, there might come a time when the deforming forces would cause deep and continually proceeding fractures. Eventually we can conceive that these fractures would split the body into fragments, each of which from its own intrinsic rigidity would be able to maintain its shape and cohesion. In such a case each of the fragments would proceed to take up an independent motion of its own. Hence, perhaps, we may see our way, without calling in any extraneous factor, to account for the present zone of asteroids, as well as explain the small size of the individuals.

This tallies, moreover, with observation. The great planets have all orbits approaching a circle; Jupiter, the greatest of all, has, with one exception, the smallest maximum of eccentricity; and Mercury, the smallest, has actually the greatest. The Leonids move in a still more elongated orbit, and they are amongst the smallest celestial objects with which we are acquainted. Altogether the minuteness of the planet and the eccentricity of the orbit have some connection in fact; this connection I cannot believe to be fortuitous, and it seems not altogether presumptuous to refer it to a common law, which we know pervades the universe. This is my excuse for attempting to venture into a hitherto unexplored region of physics, but one pointing to vast possibilities, amongst others in geology.

Shanghai, January 17. THOS. W. KINGSMILL.

The Teaching of Geometry.

I AM sure that all mathematical teachers can thoroughly endorse Prof. Minchin's letter. The difficulty of making a change lies in the University and Civil Service examinations, which still prescribe Euclid. On the continent Euclid has been superseded by modern books, some of which might serve as a basis for a thoroughly reformed English text-book.

I am convinced that the deplorable weakness shown by almost all boys in the solution of geometrical problems, arises in great measure from Euclid; they are utterly confused by its prolixity and verbiage.

And it is not as though this prolixity meant any greater accuracy or better logical sequence. It is not proved till Book iii. that a circle can only cut a straight line in two points: but in (i. 12) this property is quietly assumed, otherwise several perpendiculars could be drawn. I. 13 simply asserts that $a + (b + c) = (a + b) + c$, but is unintelligible to beginners through its verbiage. In i. 16 we practically make an angle equal to the interior one, against the exterior angle, and then ask the pupil to see for himself that one is greater than the other, which is suspiciously like *petitio principii*. In the second Book we have a number of cumbersome proofs, some of which, indeed, are now shortened to an algebraic form. (I have never been able to understand the Cambridge regulation that the sign + may be used, but not the sign −.) The Euclidean definition of proportion is quite unintelligible to beginners, while the conception of similar figures and of *scale* is easily grasped. To insist on young boys entering on the subtleties of the subject, is much as though one made a child beginning arithmetic read, say, the first chapter of Weber's Algebra. What is wanted is thorough ready knowledge of the properties of lines and circles. And for this I would strongly recommend *practical geometry*. I believe it could very easily be made a means of imparting a knowledge of geometry in its highest and widest sense. R. J. DALLAS.

15 Pemberton Gardens, N.

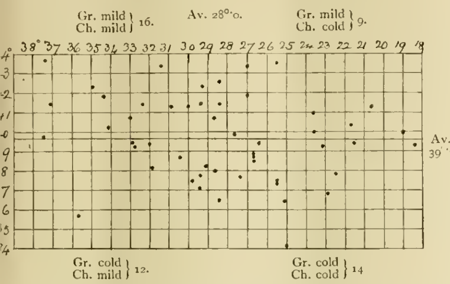
American and English Winters.

WHILE we, in the south of England, this February, have been enjoying weather of extraordinary mildness, we have read in the daily papers of bitter frost in America, and the miseries of a ferocious blizzard. It is by no means uncommon to find opposite winter weather, at the same time, east and west of the Atlantic. Can we form any exact idea as to frequency of the occurrence?

By way of seeking light on this, I have lately compared Chicago and Greenwich weather in the first quarter of the year, in the fifty-one years 1841–91; presenting the facts by a variety of the graphic method, which I do not remember to have seen

much used in meteorology, but which seems capable of various useful applications.

In the diagram herewith, the line of ordinates measures mean temperatures of the first quarters at Greenwich, and the line of abscissæ those at Chicago. The cross-lines represent averages: 39°·7 for Greenwich, 28°·0 for Chicago; and each dot, by its position, indicates the character of a winter (temperature of first quarter) at both places.



The vertical and horizontal scales being alike, one can see by the shape of the diagram how much greater are the variations of winter temperature at Chicago than at Greenwich.

If we call anything above the average *mild*, and anything below it *cold*, we find, on counting the dots in the four divisions, this state of things:—

	Cases.	
Greenwich mild, Chicago mild ...	16	30
Greenwich cold, Chicago cold ...	14	
Greenwich mild, Chicago cold ...	9	21
Greenwich cold, Chicago mild ...	12	

Thus, 21 of those 51 first quarters (say 42 per cent.) were of opposite sign, and 30 of like sign.

The distribution of dots may suggest other points of interest, on which I need not here enlarge. It would be instructive, I think, to make other comparisons of the same kind. Some time ago Prof. Hann compared the winters (December–February) at Jakobshavn, in the west of Greenland, and Vienna (*Met. Zeits.*, March 1890, p. 112), and found a larger proportion of unlike signs than the above—viz. 27 cases, against 15 of like sign.

Alex. B. MacDowall.

DANTE AND THE ACTION OF LIGHT UPON PLANTS.

In the history of vegetable physiology, sufficient importance has not been given to Dante's observations upon the action of solar light and heat upon plants, and to the ideas upon this action that existed in Italy in the fourteenth century. Sachs, in his "Geschichte der Botanik," ignores Dante and Pier de' Crescenzi completely; observing in a general way: "Of the importance of Light and Heat for the nourishment and the growth of plants, next to nothing is to be found in the authors that wrote before the last decades of the seventeenth century; although certainly the action of these agents must have been known from the oldest times, in plant culture and in several special circumstances."[1] P. A. Saccardo also, in his "Primato degl' Italiani nella Botanica," does not take any notice of the observations and opinions of Dante and of Pier de' Crescenzi on light action.

In such special works as Ottaviano Targioni Tozzetti's "Cognizioni botaniche di Dante," written in 1820: R. de Visiani's "Accenni alle Scienze botaniche nella Divina Commedia," published in 1865: and the quite recent book "Dante Georgico," in which, in a complete and able manner, Count Gastone di Mirafiore has collected all the references to agriculture, and to plants and animals, that are to be found in the "Divina Commedia" and in the minor works of Dante: the historical importance of some of Dante's observations upon light action has been overlooked; and no mention is made of the opinions prevalent upon this subject in Dante's time, as given especially by Pier de' Crescenzi.[1]

The best-known and often-quoted verses, in which the action of solar radiation upon plants is first noted in a modern language are those of "Purgatorio," xxv. 77:

> Guarda il calor del Sol che si fa vino
> Giunto all' umor che dalla vite cola;

or, in Longfellow's translation:

> Behold the Sun's heat which becometh wine
> Joined to the juice that from the vine distils.

Dante, despite his remarkable clear-sightedness in noting and describing natural phenomena, was not emancipated from what Whewell calls the commentatorial spirit of the Middle Ages; and these verses are but a powerful and poetical rendering of a passage in Cicero's "De Senectute," a book which, as may be gathered from the several quotations in the "Convivio," was much studied by Dante. There is no doubt, however, that Dante's verses have a special interest in the history of vegetable physiology; for they drew attention to the importance of their meaning in two such master minds as Galileo and Francesco Redi.

It is not unlikely that the verses of Dante influenced Leonardo da Vinci in believing that "the sun giveth spirit and life to plants, and the soil with its moisture nourisheth them,"[2] leading him to an experiment in which the importance of leaf-function in the nourishment of plants is first noted, two hundred years before Malpighi. In this experiment Leonardo caused a water-fed plant to grow prosperously and bear fruit abundantly, although its roots had purposely been reduced to "only one tiny rootlet" (*solamente una minima radice*). Leonardo thus succeeded in causing a plant to grow chiefly by its foliage, to "*vivere della cima*" ("Paradiso," xviii. 29): an experiment that would have been too dangerous for the experimenter in Dante's days. The "*vivere della cima*" was for Dante such a supernatural condition that it could only be described as possible for the symbolical tree of Heaven:

> . . . the tree, whose life
> Is from its top, whose fruit is ever fair,
> And leaf unwithering.
> —*Cary's Translation.*

The verses of Dante on the action of sunlight on the vine are paraphrased in new verses in the "Bacco in Toscana" of Redi, the poet and naturalist, in describing the growth of wine, "that lovable blood":

> Sì bel sangue è un raggio acceso
> Di quel Sol, che in ciel vedete;
> E rimase avvinto e preso
> Di più grappoli alla rete;

or, as rendered in English by C. H. D. Giglioli:

> That blood so fine is a kindled ray
> From the Sun, in heaven set,
> Entangled and held a prey
> By clustering grapes in their net.

Galileo, as Magalotti tells us, believed that "wine is a compound of light and sap." Magalotti rather diffusely

[1] Sachs, "Gesch. der Botanik," p. 387.

[1] Ottav. Targioni Tozzetti, "Delle Cognizioni botaniche di Dante espresse nella Divina Commedia." Atti dell' Accad. della Crusca. Tomo ii. (Firenze, 1829.) Roberto de Visiani, "Accenni alle Scienze botaniche nella Divina Commedia"; in "Dante e il Suo Secolo." (Firenze, 1865.) Gastone di Mirafiore, "Dante Georgico." (Firenze, 1898.) See also: G. Bottagisio, "Osservaz. sopra la Fisica del Poema di Dante." Nuova ediz. sulla prima Veronese del 1807, a cura di G. L. Passerini, Città di Castello, 1894.

[2] J. P. Richter, "The Literary Work of Leonardo da Vinci." (London, 1883.)

dwells on Galileo's opinion. Starting from Castelli's explanation of how a black surface gets more heated in the sun than a white surface, Magalotti evidently believing the sun's action to be specially powerful on the vine, tries to show how light, "that last subtle impalpable dust of bodies," must be especially entrapped by the ripening grapes, and thus become the cause of fermentation and of the strength and aroma of wine.[1] Giuseppe Del Papa, also a contemporary of Redi, one of the first to experiment on vinous fermentation, and to attempt measuring the heat developed in this process, was also of opinion (and he quotes the authority of Dante), that "both oil and wine" are formed by the action of solar light and heat upon the water contained in plants. Del Papa describes the highly penetrative action of light: "So subtle that it penetrates in every part of our body without causing sensation; but only by acting inside the eyes does light awaken that feeling which we call sight."[2]

Indeed, Newton's theory confirmed the opinion that light may enter into combination with matter. And the action of light upon plants was accounted, before and after the experiments of Ingen Housz, by Lavoisier, Senebier, Carradori and others, as a fixing or combining of light in living vegetable substances, the green colouring matter being the first product of this combination. "Experiments made on vegetation lead us to believe that light gets combined with some part of the plant, and that to this combination are due the green colour of leaves, and the various colours of flowers . . ." Thus wrote Lavoisier in 1789.[3] Senebier, who in 1788 had already noted and experimented upon the antiseptic action of light, accounted for this action by believing that light became in some way fixed upon the organic substances that are preserved from decomposition.[4]

When heat and light were no longer regarded as due to corpuscular emission, but as caused by vibrations of the luminiferous ether, the Dantesque notion of the fixation of solar heat and light died away, or rather became transformed into the notion of the storing up of energy.

An original observation by Dante is that light is the cause not only of the production of the green colouring matter of plants, but also of its decoloration. In a similitude describing the rise and wane of worldly fame, Dante writes ("Purg.," xi. 115):

La vostra nominanza è color d' erba,
Che viene e va; e quei la discolora,
Per cui ell 'esce della terra acerba;

or, in H. T. Cary's translation:

Your renown
Is as the herb, whose hue doth come and go;
And his might withers it, by whom it sprang
Crude from the lap of earth.

It has been of course a matter of ancient and common observation that the green of vegetation is produced through the action of the sun, and that the sun withers up all vegetation, causing it to fade and dry. But Dante is the first to express the double action of light on the green colouring matter, causing both the production and the bleaching of the "color d' erba." One fancies him observing the rapid bleaching of green seaweed and of other fresh vegetable matter in the sunlight, and distinguishing between the discolouring and the shrivelling action of the solar rays.

We must come down to 1686, to find again observations on the action of light on the production of the green colouring matter in plants. John Ray then distinguished between the heat-action and the light-action of the solar rays, observing that the colouring of foliage cannot be due to heat, often greater in closed dark spaces than in the open, but to the light of the sun.[1]

No exact observation upon the properties of the green colouring matter of plants could be made before a way was found of extracting the colouring principle from the vegetable tissues. This was first done, using alcohol and ether, by the two brothers Guillaume and Hilaire Rouelle, towards the middle of the eighteenth century; Hilaire Rouelle, the younger brother, published a note on the subject in 1773, remarking on the unstable properties of the green extract of plants. In 1782, Senebier had already shown that the decoloration of this green extract, prepared either with alcohol, or ether, or essential oils, is due to the action of light, and not of heat, and that the disappearing of the green colour is connected with a process of oxidation. The first experiments on the decomposition of the green colouring matter in the living plant are due to Gioacchino Carradori, in 1809.[2] Thus the observation of Dante, in the beginning of the fourteenth century, on the double action of light in producing and decomposing the green colouring matter in living plants, forestalls a discovery that was made in our century; and that has been further extended by the recent researches of N. Pringsheim.

Dante connected in a special way the vegetable activity of plants with the green of their foliage; and the effect of the specific virtue of the soul upon the body is compared to the green of leaves, the effect of vegetable life:

Come per verdi fronde in pianta vita [3]

And Dante observes that the discolouring of leaves is the sign of sickness in plants, in the vine especially (already subject to many maladies in Dante's time, as Crescenzi teaches us), remarking that the vineyard

Soon turns
To wan and withered, if not tended well;

well noting, in the word *imbianca*, the chlorotic change in the plant:

la vigna
Che tosto imbianca, se il vignaio è reo.[4]

No one before Dante, nor for many centuries after Dante, has so well noticed the depressive effect upon vegetable life of defective sunlight and persistent rain, by which roots are made to rot in the drenched soil, while leaves become discoloured and fall, and fruit fails to reach maturity:

Ben fiorisce negli uomini il volere;
Ma la pioggia continua converte
In bozzacchioni le susine vere;

or, according to Cary:

The will in man
Bears goodly blossoms; but its ruddy promise
Is, by the dripping of perpetual rain,
Made mere abortion.[5]

The best comment upon the botany of these verses, not well rendered in the English version, is in the recent experiments of Julius Wiesner, on the effect of continual rain upon different kinds of plants.

The action of sunlight in causing flowers to "awake" and to open was especially remarked by Dante, for he

1 L. Magalotti, "Lettere Scientifiche ed Erudite" (Venezia, 1740), Lettera v. See also Redi's observations in 1686 on this letter: F. Redi, "Opere. (Napoli, 1778), Tomo v. p. 134.

2 Gius. Del Papa, "Trattati vari fatti in diverse Occasioni" (Firenze, 17[illegible]4), p. 5[illegible]; and "Della Natura dell' Umido e del Secco (Firenze, 1690), p. 174.

3 Lavoisier, "Traité de Chimie, presenté dans un ordre nouveau et après les découvertes modernes" (Paris, 17[illegible]9), i. p. 201.

4 J. Senebier, "Exp. sur l'Action de la Lumière Solaire" (Genève, 17[illegible]), p. [illegible]4.

1 Joa. Raius, "Historia Plantarum," (Londini, 1686), vol. i. libr. i. p. 15.

2 G. Carradori, "Sopra la distruzione del color verde operata dalla luce in alcuni Vegetabili viventi. *Giornale di Fisica di Brugnatelli*, vol. iii. 1809.

3 "Purg., xviii. 54.

4 "Paradiso" xii. [illegible]. Cary's translation.

5 "Paradiso, xxvii 124 Cary's Translation.

forcibly describes these actions in different parts of his poem with well-known verses :

> Quale i fioretti, dal notturno gelo
> Chinati e chiusi, poi che il Sol gl' imbianca,
> Si drizzan tutti aperti in loro stelo ;[1]

or, in Cary's translation :

> As florets, by the frosty air of night
> Bent down and clos'd, when day has blanch'd their leaves,
> Rise all unfolded on their spiry stems.

And in "Paradiso," xxii. 55 :

> Così m' ha dilatata mia fidanza,
> Come il Sol fa la rosa, quando aperta
> Tanto divien quant' ella ha di possanza ;

or :

> Have raised assurance in me : wakening it
> Full-blossom'd in my bosom, as a rose
> Before the sun, when the consummate flower
> Has spread to utmost amplitude ;

and more forcibly still in "Purg.," xxxii. 54 :

> Come le nostre piante, quando casca
> Giù la gran luce mischiata con quella
> Che raggia retro alla celeste lasca,
> Turgide fansi ; e poi si rinnovella
> Di suo color ciascuna, pria che il Sole
> Giunga li suoi corsier sott' altra stella ;

but not so happily translated by Cary :

> As when large floods of radiance from above
> Stream, with that radiance mingled, which ascends
> Next after setting of the scaly sign,
> Our plants then burgein, and each wears anew
> His wonted colours, ere the sun have yok'd
> Beneath another star his flamy steeds.

The action of solar radiation in causing the rise of sap in plants, and in producing what nowadays we call vegetable transpiration, was especially noticed in the time of Dante, four hundred years before the experiments of Guettard.

Pier de' Crescenzi, the famous agricultural writer of Bologna, was a contemporary of Dante, and he lays special stress on the action of solar heat and light upon plants. Crescenzi's work, the "Opus Ruralium Commodorum," was written in 1305, when the "Divina Commedia" was not yet finished, and when a part of the "Convivio" had not been written. Crescenzi's book, originally written in Latin, became so popular that in the lifetime of the author, or shortly after his death, it was translated into Italian ; and since then, down to the beginning of this century, that book (it was among the first books printed, the first edition being of Strassburg, 1471) remained the standard agricultural encyclopædia, republished in thirty Italian editions, and translated into the chief languages of Europe.

It is from Crescenzi that we gather best what Dante's ideas were on the action of light upon plants ; and to Crescenzi we must look as the fountain-head of the ideas prevalent on that subject during many centuries. Crescenzi likened the vegetable to a man planted with his head downwards in the soil and all his limbs in the air. For the roots of a plant were considered the really vital part of the organism, its head and heart in one, by which, with many mouths, the roots sucked up with moisture the food prepared in the soil by the corruption of corruptible things. The soil was for plants what the stomach is to animals. Four hundred years later we still find Linnæus writing that *plantarum ventriculus est terra.* According to Crescenzi, not only is solar radiation the cause of the sucking-up action of vegetables, but also of the transformation and assimilation of plant food, separating the water with which it is mixed, the water being then transpired away.

[1] "Inferno," ii. 127.

Thus Crescenzi finds that the growth and ramifying of plants is due to two causes : nourishment from the soil and the action of sunlight : "Branches . . . multiply for two reasons : one of which is material, namely the abundance of nourishment ; and the other is efficient, that is the heat of the sun, which on all sides toucheth the tree, and causeth the sap to boil up, and draweth it forth ; and therefore many branches shoot outwards in the upper parts, where the sap is more straitened, and is rendered more subtle by digestion. And the true proof of this is that plants which are surrounded by many other plants, as happens with trees in thick and shady woods, grow high, and do not produce many branches, nor are their trunks thick, and they have a certain lack and feebleness of branches ; for, by want of sun, their sap is not drawn forth, nor does it boil at their outer extremities ; for the coldness of the shade keeps in the heat which being constrained inside, fleeing from its contrary, sendeth on high all the nourishment."[1]

". . . The sap is a humour which, through the pores of the roots is attracted to nourish all the plant, and by its nourishing power gets distributed in all the parts of the plant ; and it is necessary that it should be changed to the similitude of the plant by digestive heat."

". . . the nourishing humour of plants is more insipid when in the root, but as it goeth farther and farther from the root, the more it gaineth in taste convenient to the plant ; and in the same way as it gaineth in savour, so doth it gain in density and in subtlety and in acidity ; for by the action of heat these changes must occur. . . ."[2]

". . . because fruits require much power of the sun, leaves are placed somewhat distant from the fruits, so that these be not in the shade, and the digestion be not prevented that is done by the sun."[3]

". . . the sun's heat giveth, as it were, perfection and form, and nearly giveth life ; for this reason moisture is formed in plants continually."[4]

The hardening influence of light upon vegetable tissues, and the favouring of growth by heat in the absence of light are, for the first time in the history of plant life, noticed by Crescenzi, who thus shows that he formed some idea of the distinct action upon plants of heat and light : "Plants in warm weather grow in the darkness of night ; and in the heat of the sun they harden and become woody."[5] This is a precise and simple statement of facts, without any reference to the action of the moon, as we find in later writers, such as Levinus Lemnius, the celebrated Dutch doctor, in his curious book, "De Occultis Naturæ Miraculis," published in 1559.[6]

It is by Carradori, at the beginning of this century, that we again find stress laid on the action of light in giving robustness and hardness to vegetable tissues. Indeed, the words of Crescenzi may be paraphrased with those of the most eminent writer on the physiology of plants of our own times : "So far as plants are concerned, warmth chiefly signifies growth ; while light, on the other hand, brings about nutrition."[7]

Even as late as Liebig sufficient importance was not given to the action of light in hardening growing tissues ; and only the experiments of Sachs and of Ludwig Koch have explained to us the reason why thick seeding, or a luxuriant vegetation, is followed by the laying of wheat and other high grasses.

It is evident that in the days of Dante a new spirit of inquiry was beginning, regarding not only the life of

[1] Per de Crescenzi, "Trattato dell' Agricoltura," libr. ii. cap. 5.
[2] *Id.*, libr. ii. cap. 4. [3] *Id.*, libr. ii. cap. 6.
[4] *Id.*, libr. ii. cap. 25. [5] Pier dei Crescenzi, libr. xi. cap. 14.
[6] Lemnius writes : "For we see that plants receive nourishment that is moved by the heat of the sun ; and by night this food is diffused so that the food getteth increase . . . by day, by virtue of the sun, all things ripen ; and by night, by virtue of the moon, they are filled with humour and get swollen.
[7] Julius v. Sachs, "Lectures on the Physiology of Plants," trans. by H. Marshall Ward (Oxford, 1887), p. 198.

plants and the action of sunlight, but all natural phenomena. It would seem as if there were other than a purely theological meaning in the words by which Virgil, the master of the ancient knowledge, emancipates Dante from old learning and art, and opens to him the gates of new knowledge by admonishing him to look for himself, look to the sun shining before him, and to all the plants and trees growing spontaneously around :

> . . . Lo tuo piacere omai prendi per duce ;
> Fuor sei dell' erte vie, fuor sei dell' arte.
> Vedi là il Sol che in fronte ti riluce ;
> Vedi l' erbetta, i fiori e gli arboscelli,
> Che qui la terra sol da sè produce.
> . . . .
> Non aspettar mio dir più, nè mio cenno :
> Libero, sano e dritto è tuo arbitrio,
> E fallo fora non fare a suo senno ;
> Perch' io te sopra te corono e mitrio ;[1]

or, in Wright's rendering :

> Take thou thy pleasure for thine escort now—
> Forth of the steep and narrow way emerged.
> Behold the sun upon thy forehead thrown—
> Behold the trees, the flowers, of every hue,
> In this most happy soil spontaneous sown.
> . . . .
> No more from me expect or sign or word :
> Thy will henceforth is upright, free, and sound :
> To slight its impulse were a sin : then lord
> Be o'er thyself ;—be mitred, and be crowned.

The splendour of the ancient literatures, dawning again upon Italy, overpowered the rising of the new science. The generations that followed Dante became more erudite than learned ; and the new knowledge slept again through the centuries, just showing life with Leonardo da Vinci, and a few others, until the "unlocking of the gates of sense, and the kindling of a greater natural light," in the days of Bacon and Galileo. ITALO GIGLIOLI.

[1] "Purgatorio," xxvii. 131.

THE REV. W. COLENSO, F.R.S.

WE briefly announced in our issue of February 16 the death of the Rev. William Colenso, F.R.S., of Napier, New Zealand. The close of so interesting a life, which for more than half a century has been intimately associated with the progress of science and education in the antipodes, is one that demands more than a passing reference in the columns of NATURE.

Mr. Colenso was the son of the late S. M. Colenso, a saddler of Penzance, and was born in that town in 1811. He was put to learn the arts of printing and bookbinding in London, where he was eventually employed for a time on behalf of the British and Foreign Bible Society. In 1833 the Church Missionary Society determined to establish a printing press in the then almost *terra incognita* of New Zealand. Mr. Colenso was selected to take charge of the enterprise, with results that must have more than justified the most sanguine expectations. An account of his early experiences in the joint capacity of printer and missionary was published by him in 1888, under the title of "Fifty Years ago in New Zealand," and a more interesting history of pioneer work of the kind undertaken by Mr. Colenso, performed as it was under exceptionally unfavourable conditions, it would probably be impossible to find. "In December 1837," says the technical journal *Typo* (April 26, 1890), "under difficulties such as perhaps no printer ever had to surmount since the first invention of the art, Mr. Colenso completed his great work (a translation into Maori of the entire New Testament, in octavo, small pica type." From about the year 1840 Mr. Colenso devoted himself principally to mission work. In 1844 he took orders, after preparation under Bishop Selwyn. In the same year he settled at Hawkes Bay, where he resided for the rest of his life.

An ardent lover and student of nature, Mr. Colenso has left behind him a distinguished record as a botanist and as an authority upon the natural history of the archipelago. For his services to botanical science he was in 1886 elected a Fellow of the Royal Society, having been previously made a Fellow of the Linnean Society. The wild woods and mountains of his island home, traversed unremittingly by him in his missionary avocations, exercised throughout his life an ever-increasing fascination on his mind. With the Maoris his acquaintance was necessarily of a most intimate character ; and he became an authority second to none on the subject of their language, arts, and legendary lore.

On June 25, 1896, a notice appeared in NATURE of the generous scheme for the foundation of a museum that Mr. Colenso had put before a meeting of the Hawkes Bay Philosophical Institute. The enlightened spirit in which the scheme had been conceived is shown by the extract which we printed from Mr. Colenso's address to the meeting. In offering 1000*l*. as a nucleus of the fund required for the establishment of the museum, he imposed the condition, among others, that the museum should be opened on Sunday afternoons as well as on every weekday. It is stated in the Cornish press that the reception accorded to his munificent offer was very disappointing to him, and that the scheme was withdrawn by him in the following year, with the announcement that his books and money would go to his native town. He had already presented 1000*l*. to the borough of Penzance, the income from the investment of which sum is utilised for annual gifts to the deserving poor. At the end of 1898 this fund, known as the "Colenso Dole," was increased by a second donation of 1000*l*.

Mr. Colenso's zeal in the pursuit of science, and his enthusiasm for missionary work did not exhaust his energies. He discharged important public duties from time to time. In the days when the relations between the natives and the colonists were strained he acted as a negotiator in the interests of the Maoris, and was the last survivor of the English signatories of the treaty of Waitangi. He was a member for Napier in the first General Assembly, and retained the seat for many years.

Mr. Colenso was a first cousin of the late Bishop of Natal. There are marked points of resemblance between the spheres in which the two men worked, and it is not surprising that the former felt himself to be in close sympathy with his South African namesake on the subjects which the Bishop had at heart.

This fact, and the untiring energy which sustained Mr. Colenso in his latest years, are evidenced by the following extracts from a letter which he wrote to a correspondent in London barely two years ago. He said : "I am leaving here to-morrow morning by rail for the Bush district (that is the forest country) in the interior, having Church duty at Woodville, 100 miles S., on Sunday next, the Vicar being unwell. Last Sunday I took Church duty here at St. Augustine's, and on the Sunday before at Clive, a village nine miles E. towards Cape Kidnappers. I am far too old (eighty-six) to undertake the duties of a *parish*, but I *love* my *work*, and am always ready to help as far as I am able." He then adds that he had always been "a great admirer and supporter" of Bishop Colenso's "theological works." "I have them here," he writes, "and have often studied them. I particularly like his volumes of Natal sermons, &c., and went with him wholly in the matter of the oppressed and ill used Zulus."

It is greatly to be hoped that the preparation of a biography of this remarkable man may fall into thoroughly competent hands.

NOTES.

Lord Lister has been elected a foreign associate of the Paris Academy of Medicine.

Prof. E. Ray Lankester, F.R.S., has been elected a correspondant of the Paris Academy of Sciences.

Prof. L. Cremona, of Rome, Prof. Ray Lankester, and M. Alexander Karpinsky, of the Institute of Mines of St. Petersburg, have been elected Associates of the Belgian Academy of Sciences.

We regret to see the announcement of the death of Sir John Struthers, Emeritus professor of anatomy in Aberdeen University, at seventy-six years of age.

The Belgian Royal Academy has awarded prizes of 600 francs to M. Georges Clautriau, of Brussels, for his memoir on the macro- and micro-chemistry of digestion in carnivorous plants, and to Prof. L. Cuénot, of Nancy, for his essay on the excretory organs of Mollusca.

Replying in the House of Commons on Monday to a question upon the preservation of rare animals in Africa, Mr. Brodrick said: "Steps have already been taken to guard against undue destruction of wild animals by the issue of game regulations, and we are in communication with the German Government as to collective action. It is proposed to hold an international conference in London in the spring."

A prize of 500 francs, founded by Augustin-Pyramus de Candolle for the best monograph on a genus or family of plants, is offered in competition by the Société de physique e d'histoire naturelle de Genève. The monographs may be composed in Latin, French, German, Italian or English, and must be sent to M. Pictet, the president of the Society, before January 15, 1900. Members of the Sciety are not permitted to compete.

At a meeting of the Manchester and Salford Trades Council, held on February 16, the following resolution was passed:—"That this Council desires to again express its sympathy with the objects of the Decimal Association, believing that by their adoption the interests of commerce and industry throughout the United Kingdom will be much benefited." All the leading Trades Unions in Great Britain strongly support the movement for the adoption of the metric weights and measures by this country, and on two occasions at the Congress of Trades Unions resolutions in favour of this reform were unanimously passed.

A recently issued number of the *Nouvelles Archives* of the Muséum d'Histoire Naturelle of Paris contains a full description, accompanied by coloured figures, of a very remarkable new monkey lately discovered by the French missionaries in Eastern Tibet, and proposed to be named *Rhinopithecus bieti*, after Mgr. Biet, the head of the Mission. It inhabits the western slope of the chain of mountains which separates the valley of the Mekong from that of the Yang-tze, in the district of Tsékou, where it is known to the natives as the *Tchru-tchra*, or "snow-monkey." This is the third species of monkey now known to inhabit high altitudes in Eastern Tibet.

During the last week or ten days the weather over the British Isles has partaken both of winter and summer, the nights being characterised by sharp frost, while the days have been bright and warm. From about February 19 an anti-cyclone has enveloped most of the country and the greater part of Western Europe. The early mornings especially have been densely foggy in the neighbourhood of the metropolis; the day temperature in the screen has reached 55°, while at night the sheltered thermometer has fallen to 22°. No rain has been recorded over a large part of England since February 15, and in the *Daily Weather Report* issued by the Meteorological Council on February 27 the unusual occurrence was recorded of the absence of rain over the whole of Western Europe, between Bodö, within the Arctic circle, and Lisbon.

The British Fire Prevention Committee, the establishment of which was the outcome of the Paris Charity Bazaar and Cripplegate fires, has now become a fully incorporated scientific society under the special sanction of the Board of Trade.

Mr. Robert J. Aley contributes to the *Proceedings* of the Indiana Academy of Science (1897) a list of seventy-one collinear sets of points connected with the geometry of the triangle, with references for proofs to well-known text-books. The list should prove useful for purposes of reference.

In the *Atti dei Lincei*, viii. 1, 2, Signor P. Pizzetti contributes two notes on the intensity of gravity on Mont Blanc. The values for g observed on the slopes on the mountain lead the author to conclude that the attraction of the mountain is only to a small extent compensated for by deficiencies in internal mass. Such deficiencies cannot be much below those represented by a stratum of 1000 metres thickness. At Chamounix, on the other hand, the deficiency seems to be far smaller.

We learn from the *Pioneer Mail* that preparations for the introduction of the electric light into Calcutta are going on apace. Mains are being laid, and the central station, where fifteen hundred horse-power will be employed in generating the current, is approaching completion. The dynamos will shortly be running, and the current available for the supply of private houses; so that electric fans driven by the current will soon replace the coughing, slumbering punkah coolie. The engines which are being set up will be entirely devoted to the production of the electric light and the driving of electric fans, a further installation being contemplated for the trams when these come to be driven by electricity.

It has been resolved that the memorial to the late Prof. Coats, of Glasgow University, shall take the form of a University prize or scholarship in connection with pathology. To carry out this a sum of at least 1200*l*. will be required. Circulars are being issued calling for subscriptions, which will be received and acknowledged by Dr. David Newman, honorary secretary, 18 Woodside Place, Glasgow, or Mr. James J. MacLehose, honorary treasurer, 61 St. Vincent Street, Glasgow.

Numerous friends of the late Prof. Kanthack have expressed the wish that his work should be commemorated in some suitable way. It is proposed to raise a fund, the interest of which shall be devoted to the use of Mrs. Kanthack during her life, whilst the capital amount can eventually be employed in founding some permanent memorial to the late Dr. Kanthack. All who desire to contribute to the fund are requested to send subscriptions to Dr. J. H. Drysdale, 25 Welbeck Street, London, W.

Referring to the late Dr. Alexandre Laboulbène, professor of the history of medicine in the University of Paris, who died recently at the age of seventy-three, the *British Medical Journal* remarks that he had won great distinction as a pathologist and an entomologist before he was appointed to the chair which he occupied for the last twenty years of his life. He was the author of a large number of papers on pathological and entomological subjects, presented not only to the Académie de Médecine, but to the Société de Biologie, the Société Anatomique, and the Société Entomologique de France. Prof. Laboulbène was president of the Académie de Médecine in 1893.

The Association of American Anatomists has accepted the propositions of the editors of the *Journal of Anatomy and Physiology*, and have adopted the journal as the official organ of the Association. Dr. G. S Huntington, professor of anatomy, Columbia University, New York City, has been nominated as the American editor. At the recent meeting of the Association, the president, Dr. Burt G. Wilder, discussed "Misapprehensions as to the Simplified Nomenclature." He urged especially a fuller recognition of what had been done by the English anatomists, Barclay, Owen, Pye-Smith and T. Jeffery Parker, and hoped the nomenclature of the future would be called the "Anglo-American."

We learn from the *American Naturalist* that the department of scientific investigation of the United States Fish Commission is being developed by Prof. Bumpus. The laboratory at Woods Holl is to be kept open throughout the year, and students are welcomed there at any time. The facilities of the various stations are placed at the command of those who wish embryological or other material. In the line of research, it is stated that the department has arrived at the conclusion that the late increase in the number of starfish in the oyster-beds of Southern New England, and especially in Narragansett Bay, is directly related to the capture of the menhaden and other fishes for the oil and fertiliser factories. These surface-feeding fishes formerly destroyed large numbers of starfish eggs and larvæ; but since they have been caught so persistently, the starfish have got the upper hand.

The first year of the marine biological station at Millport appears to have been a satisfactory one. The Committee of the Millport Marine Biological Association report good progress, not only in regard to the numbers who visited the Robertson Museum, and to the degree in which the facilities afforded by the laboratory were utilised by scientific workers, but also in regard to the measure of public support accorded to the scheme. There were over 8000 visitors to the museum during the past year, and tables in the laboratory were utilised for terms varying from a week to a month on thirty-eight different occasions. While the Committee have reason to be gratified with the present degree of equipment of the station, and with the facilities it affords for biological work, they recognise that, in order to take full advantage of the surrounding sea area, and to bring the station into line with the best-equipped institutions elsewhere, some considerable additions were still required. It is hoped that as the station becomes better known its complete equipment will follow. It would be extremely gratifying to the Committee were this end accomplished before the meeting of the British Association in Glasgow in 1901.

To afford the members of the Franklin Institute, Philadelphia, the opportunity of cultivating an interest in photography and microscopy, with especial reference to the branches of photographic optics and mechanics, photo-micrography, photochemistry, and their manifold applications to the various branches of the arts and manufactures, a photographic and microscopic branch of the Chemical Section is being organised. Of interest in connection with this movement, is the fact that the Chemical Section of the Institute has lately become the residuary legatee of the large and valuable accumulation of scientific books and physical and chemical apparatus of the late Mr. Mathew Carey Lea.

The historical sketch of the first federated institute, which included mining engineers from all parts of the world, given by Mr. Bennett H. Brough in a paper read before the Institution of Mining Engineers, at the general meeting held on February 22, is of interest to other societies besides that before which it was read. The original idea of forming such an institute is said by Mr. Brough to have been due to the distinguished Austrian mining engineer and metallurgist, Ignaz von Born. The society was established in 1787 under the name Societät der Bergbaukunde, and it was the prototype of the mining institutes of the present day. The object of the society was to afford a means of communication between mining engineers of all nationalities, on matters bearing upon the mining industry. Mining experts from all parts of Europe, and even from Mexico and South America, were enrolled as members. Only two volumes of *Transactions* were published, the first in 1789; and, probably owing to the death of von Born, which occurred at the age of forty-eight, at Vienna, on July 24, 1791, and to financial difficulties, the society soon came to an end.

At the meeting of the Franklin Institute, Philadelphia, on February 15, Mr. L. E. Levy exhibited and described the acid blast process invented by him to facilitate the etching of photochemical engravings. The invention consists essentially in the application of a spray of finely atomised etching liquid instead of the immersion bath at present in use, the spray being driven against the plate by a powerful blast of air from an air-compressor. Under the impulse of the blast the etching proceeds very rapidly. The heat evolved by the rapid chemical decomposition of the metal is absorbed by the expansion of the compressed air as it escapes into the etching compartment, and this results in keeping down the temperature of the plate and the etching liquid to a normal degree. As each succeeding globule of acid impinges on the metal in the direction in which the etching is required to proceed, the process can be continued to a depth beyond which the finer and closer lines of the design would become too frail to bear the strain of printing, and at that point the etching is stopped and the finer lines are protected by powdering in the usual way, after which the etching can be carried to the requisite depth. Attached to the etching box is a washing compartment, into which the plate carrier is slid when the etching liquid is to be washed away from the plate.

The committee appointed by the council of the Society of Arts to inquire into the requisite conditions of safety in acetylene gas generators, and to report on the various apparatus shown at the exhibition held at the Imperial Institute, has just published their results and conclusions. The committee classified the generators into three groups: (1) those in which the gas is generated by water being allowed to drip or flow on to the carbide; (2) those in which the water is allowed to rise in contact with the carbide, the rise being regulated by the increase of pressure in the generating chamber; (3) those in which the carbide drops into the water. These are again subdivided into—automatic generators, whose storage capacity is less than the total volume which the charge of carbide is capable of generating, and which, therefore, require automatic regulation; and non-automatic, whose holders can receive all the gas produced by the charge of carbide. It is concluded that the tests have clearly demonstrated that many types of acetylene gas apparatus can be so constructed as with ordinary precautions to be absolutely safe, and that lighting by acetylene need be no more fraught with danger than any other form of artificial lighting in general use. But though the committee consider acetylene gas to be safe when generated in a properly constructed apparatus outside the building to be lighted, and in accordance with the rules and suggestions contained in the report, they point out that the generation of gas within the house, and the use of hand lamps, cycle lamps, &c., is not unattended by danger, except in skilled hands.

The Trustees of the Indian Museum have just distributed an important memoir by Major A. Alcock, superintendent of the Museum, and professor of zoology in the Medical College, Calcutta, containing an account (with plates) of the deep-sea

Madreporaria collected by the Royal Indian Marine Survey ship *Investigator*. This is the first independent report upon a single group of the zoological collections made by the *Investigator*, and accumulated at the Indian Museum since 1885. It must, however, be remembered that the deep-sea dredging operations only form a small part of the work of the officers of the Marine Survey, rarely more than twenty deep-sea hauls being made in one year. Only the deep-sea Madreporaria dredged at a depth greater than 100 fathoms are included by Major Alcock in his memoir. In this collection there are only twenty-five species and fourteen genera. In the Indian Seas, "deep" forms of Madreporaria are found to occur in greatest abundance at a depth of between 400 and 600 fathoms, where the bottom temperature generally ranges from about 48° Fahr. to 44° Fahr. The sea in which corals were found in the greatest abundance and variety was the narrow basin between the Laccadive and Maldive Islands on the west, and the Malabar coast on the east. With regard to the geographical distribution of the corals, the lists of species prepared by Major Alcock show so many intimate affinities of the fauna of the Indian Seas and the North Atlantic fauna, that the conclusion is arrived at that there was formerly a direct sea connection between the Atlantic and Indian Oceans, the connection being by way of the Mediterranean.

MR. JOHN WHELDON, Great Queen Street, W.C., has issued a catalogue of scientific books and papers offered for sale by him.

ILLUSTRATIONS of the good work done at the Hull Botanical Laboratory (U.S.A.) are furnished by two papers, of which we have received reprints, from the *Botanical Gazette*—the effect of aqueous solutions on the germination of fungus-spores, by T. L. Stevens; and the life-history of *Lemna minor*, by Otis W. Caldwell.

THE first part of the *Transactions* of the English Arboricultural Society for 1899 contains three papers on practical forestry: on the different methods adopted in the measurement of standing and felled timber, by Mr. T. Bright; on the planting, maintenance and management of a plantation for the first twenty-five years, by Mr. J. E. Dalgleish; and on the felling and barking of oak and larch timber, and the preparation of the bark, by Mr. A. J. Ross.

IN the *Bulletin International* of the Academy of Sciences of Cracow for January 1899, we have a full German translation of the important paper by W. Rothert, to which we have already referred, on the structure of the vegetable cell-wall. He sums up the general results in the statement that a reduction of the typical structure may take place in two ways—either by the attachment of the thickening bands by their greatest breadth: in other words, the replacement of bordered by simple pits; or by the imperfect formation of the thickening bands, and in their looser arrangement.

THE following items of information in regard to biological stations are taken from the *American Naturalist*:—The University of Indiana will locate its biological station this year at Warsaw, Ind.—Cornell University will maintain summer schools during the coming summer in botany, entomology, geology, and zoology.—The Natural History Society of St. Petersburg has established a biological station on the shores of Lake Bologoy.—It is under contemplation to establish a permanent biological station on the shore of Casco Bay (U.S.A.), which is remarkably rich in animal life.

IN the *Journal* of the Royal Microscopical Society for February is an interesting paper by Mr. J. Newton Coombe, on the reproduction of diatoms, in which the author supports the view of Mr. George Murray, that certain diatoms may reproduce themselves, either by a rejuvenescence of the cell and the excretion of a new frustule within the parent, or by the formation, by division of the protoplasm, of a number of new individuals within the parent.—Mr. A. W. Waters contributes a paper on Bryozoa from Madeira.—In the summary of recent researches is a translation of Dr. H. Harting's highly technical paper on formulæ for small-apertured objectives; and one of a paper by Herr Karl Strehl on the theory of the microscope.

AT the last meeting of the Anatomical Society of Great Britain and Ireland, some important additions were made to our knowledge of the morphology of the liver of higher Primates. It has always been rather a moot point whether the rather solid, slightly fissured liver of man and the anthropoid apes corresponds to the whole of the multilobulated liver of the lower Primates, or only to its central part. From the specimens and drawings of human fœtal and anthropoid livers, shown by Prof. Arthur Thomson, of Oxford, at the Anatomical Society, there can be no doubt that the liver of the higher Primates has been evolved out of the multilobulated organ of the lower Primates by a process of fusion. He was able to show that even in the liver of man there were always minute fissures on the under surface of the right lobe, indicating a more primitive form of lobulation, and which were much better represented in the liver of the gorilla. It is strange that the gorilla, which shows in so many points the nearest approach to man of all the anthropoids, should in this organ stand furthest away from him and approach the lower apes. According to Prof. Thomson, the liver of the gorilla is rather variable in its fissuring, and so is that of the orang. The anthropoids show every stage of the caudate lobe, intermediate to its development in ordinary monkeys and its vestigial state in man. On the other hand, Prof. Parsons and Dr. G. F. Rogers drew attention to abnormal fissuring and lobulation of the human liver that did not correspond to any forms found amongst the Primates.

ACCORDING to Dr. Arthur Keith, the peculiar shape and structure of the human and anthropoid liver is an adaptation to erect posture. With the assumption of this posture by the higher Primates, all the organs of the abdominal cavity acquired a much more extensive fixation to the roof and posterior wall of that cavity. The liver no longer rested on the belly wall, as it does in the lower Primates, but was extensively fixed by its posterior surface to the back and roof of the abdominal cavity. The more extensive fixation of the liver led to the obliteration of its deep fissures. The fissures of the liver are certainly of physiological importance to the lower forms, for they allow the lobes of the liver to glide upon each other, and separate as that organ descends in inspiration.

AT the meeting of the Anatomical Society already referred to, Mr. R. H. Burne communicated an account of the curious biliary net-work formed by the cystic and hepatic ducts of the common otter, shown by no other mammal, and which recalled the arrangement found in certain reptiles.

THE third part of the "Catalogue of the African Plants collected by Dr. Friedrich Welwitsch in 1853-61," by Mr. W. P. Hiern, has been published by the Trustees of the British Museum (Natural History). The volume contains descriptions of the natural orders of Dicotyledons from Dipsaceæ to Scrophulariaceæ. A short description of the Catalogue appeared in NATURE of May 1897 (vol. lvi., p. 52).

A NEW edition—the fifteenth—of the volume on "Telegraphy," by Mr. W. H. Preece, C.B., F.R.S., and Sir James Sivewright, K.C.M.G., in Longmans' Text-Book of Science Series, has just been published. The work originally appeared in 1876, but the advances since then have been so great that it has been reconstructed several times. The present edition con-

tains a large amount of new information, and the whole work has been thoroughly revised.—In the new form in which Messrs. Henry Holt and Co. have published the fifth edition of Prof. Newell Martin's clearly-written work on "The Human Body," the book will probably meet with increased success. The work has been revised by Dr. George W. Fitz, and several chapters have been rewritten. The directions for demonstrations and experiments has been greatly enlarged and collected in an appendix. Many new illustrations have also been included. The volume is now published in the American Science Series, and it makes a text-book of convenient size on anatomy, physiology, and hygiene.—A fifth edition of Marshall and Hurst's well-known and widely used "Junior Course of Practical Zoology," revised by Mr. F. W. Gamble, has been published by Messrs. Smith, Elder, and Co. The plan of the work has not been changed, but the chapters on technique have been recast, and a few alterations and additions have been made.

Our knowledge of the molecular weights of inorganic substances is in great part derived from the classical researches of Victor Meyer and his pupils on vapour densities at very high temperatures. A few determinations of the molecular weights of inorganic salts have also been made by the boiling-point method, the most interesting conclusion obtained in this way being that cuprous chloride and bromide are represented by the simple formulæ CuCl and CuBr. In the current number of the *Gazzetta Chimica Italiana* the problem is attacked by N. Castoro by the cryoscopic method. A satisfactory solvent was found in urethane, in which a considerable number of inorganic substances can be dissolved. The lowering of the melting point was determined for silver nitrate and the chlorides of mercury, cobalt, copper, cadmium, zinc, tin, and manganese. Of these, cupric and cobalt chlorides had the double formulæ Cu_2Cl_4 and Co_2Cl_4 quite clearly marked; manganese chloride showed some tendency to the formation of double molecules; whilst the remaining salts gave figures closely agreeing with those calculated on the assumption of the simple formulæ.

The additions to the Zoological Society's Gardens during the past week include a Long-tailed Marmot (*Arctomys caudatus*) from Gilghit, presented by Mr. A. H. McMahon; a Rough-legged Buzzard (*Archibuteo lagopus*), European; a Virginian Eagle Owl (*Bubo virginianus*) from North America, presented by the Hon. Walter Rothschild, M.P.; two Common Herons (*Ardea cinerea*), European, presented by Mr. F. G. Bridgman; a Pale-headed Parrakeet (*Platycercus pallidiceps*), a Rose Hill Parrakeet (*Platycercus eximius*) from Australia, presented by Mr. W. F. Clayton; a Cockateel (*Calopsittacus novae-hollandiae*) from Australia, presented by Mr. Edward Hawkins; a Camboyan Turtle Dove (*Turtur senegalensis*) from Africa, presented by Mr. D. Seth-Smith; a Common Paradoxure (*Paradoxurus niger*) from India, presented by Mr. W. O. Sheppard; a Brazilian Tortoise (*Testudo tabulata*) from South America, presented by Mr. John Gordon; a Great Eagle Owl (*Bubo maximus*), European; two Black-backed Piping Crows (*Gymnorhina tibicen*), four Laughing Kingfishers (*Dacelo gigantea*), two Black Swans (*Cygnus atratus*) from Australia, deposited; two Yellow Conures (*Conurus solstitialis*) from Guiana, purchased.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in March:—

March 3. 12h. 21m. Minimum of Algol (β Persei).
3. 13h. 5m. to 14h. 2m. Occultation of the star B.A.C. 5254 (mag. 5·4) by the moon.
6. 9h. 10m. Minimum of Algol (β Persei).

March 15. Venus. Illuminated portion of disc 0·644. Apparent diameter 18″·2.
Mars. Illuminated portion of disc 0·922. Apparent diameter 9″·7.
Jupiter. Apparent Polar diameter 38″·9.
16. Saturn. " " 15·4. Outer minor axis of outer ring 17″·34.
20. 5h. 32m. to 6h. 50m. Occultation of 56 Geminorum (mag. 5) by the moon.
20. 8h. 50m. to 9h. 59m. Occultation of 61 Geminorum (mag. 5·7) by the moon.
20. 8h. Sun enters Aries. Spring commences.
24. 9h. 48m. to 10h. 47m. Transit of Jupiter's Sat. III.
24. 11h. Mercury at greatest elongation, 18° 36′ East.
25. 16h. 52m. to 17h. 45m. Occultation of ε Leonis (mag. 5·1) by the moon.
26. 10h. 52m. Minimum of Algol (β Persei).
27. 10h. to 10h. 56m. Occultation of DM − 10°, 3570 (mag. 6) by the moon.
28. 9h. 57m. to 10h. 49m. Occultation of 83 Virginis (mag. 5·8) by the moon.
30. 11h. 59m. to 12h. 40m. Occultation of DM − 22°, 3989 (mag. 6) by the moon.
31. 13h. 11m. to 14h. 10m. Transit of Jupiter's Sat. III.

Mercury will be very favourably displayed as an evening star from about March 17 to 27. The times of his setting and the intervals by which he follows sunset are as under:—

1899	Sunset h. m.	Mercury sets h. m.	Interval h. m.
March 17	6 6	7 38	1 32
18	6 7	7 45	1 38
19	6 9	7 51	1 42
20	6 10	7 56	1 46
21	6 12	8 1	1 49
22	6 14	8 5	1 51
23	6 15	8 9	1 54
24	6 17	8 12	1 55
25	6 19	8 14	1 55
26	6 20	8 15	1 55
27	6 22	8 16	1 54

New Nebulæ.—We learn from *Harvard College Observatory Circular*, No. 38, that Dr. De Lisle Stewart, who is in charge of the Bruce photographic telescope, has found recently an interesting group of nebulæ, hitherto unknown, on plates taken October 14 and October 20, 1898.

Comparison examinations of both plates show the presence on each of forty-six objects, which are given in a table showing their coordinates and a short description of each. The group is situated within the limits of right ascension 3h. 10m. to 3h. 50m (1900), and declination − 49° 50′ to − 53° 40′ (1900).

Of the whole group only two are identical with the nebulæ given in Dreyer's New General Catalogue, viz. N.G.C. 1311 and N.G.C. 1356. Four of the new nebulæ appear to be distinctly spiral. One is described as having a "bright elongated centre, and others as faint nebulous wisps in ellipses or spirals." Three are nebulous stars surrounded by nebulosity.

Nebulosities of the Pleiades.—For several years there has been some controversy between various authorities as to the real or spurious nature of certain wisp-like forms which are obtained on plates exposed on the region surrounding this star cluster. Prof. Barnard maintains that the appearances are due to real nebulosity, and supports his case by showing identical forms on various plates taken with widely different lenses and with varying exposures; while Dr. Roberts, who cannot find these markings on his plates, attributes them to surface markings due to sky glare or defects of the plates. Mr. H. C. Wilson, of Goodsell Observatory, Minn., supports Prof. Barnard's case by an article in *Popular Astronomy*, vol. vii. No. 2 (February), which he illustrates with three photographs of the region taken by himself. Two of these were taken with a camera of about 36 inches equivalent focus, the objective being a quadruplet six inches in diameter. One of the plates was taken in October 1894, with an exposure of 11h. 15m., the other in November 1898, with an exposure of 5h. 35m. The regions of nebulosity to which he draws attention are quite easily seen on the reproduction, lying chiefly to the north-east of the star cluster, and the boundaries of the hazy masses are exactly

similar in the two plates. Moreover, the author states that the forms shown on his plates agree very closely with those obtained by Prof. Barnard in 1893; so that there being at least three photographs showing identical forms, the evidence is greatly in favour of their being true cosmical matter, as it is inconceivable that chance markings could exhibit such coincidences. To explain their absence on Dr. Roberts's plates, the author thinks that the atmosphere at Goodsell Observatory must be much clearer than is the case in England, giving as his reason the fact that the star images on his plates are much less surrounded by atmospheric glare than those of Dr. Roberts. Indeed, even with the long exposure of over eleven hours, the star discs are still easily discernible on the reproductions, showing that the observing conditions must have been extremely perfect.

METEOR PHOTOGRAPHY.—Those who may be interested in this branch of astronomy will find the illustrated description, by Mr. W. L. Elkin, of the apparatus used for this purpose at the Yale University of considerable value (*Astrophysical Journal*, vol. ix. p. 20, January).

The instrument consists of a long polar axis, driven by clockwork, and provided with means of attachment for from eight to twelve cameras round its circumference. The lenses used for this purpose are selected for their rapidity; hence we find that portrait lenses are in nearly all cases chosen. During the last November Leonid shower eight cameras were used with the instrument; six of these carried portrait lenses of from six to eight inches aperture and from twenty-seven to thirty-six inches focus, the remaining two being provided with lenses four inches in diameter.

It is, however, not indispensable to have an expensive clock-driven mounting, and for the same meteor shower a simpler apparatus was also used, having a wooden polar axis turned intermittently at intervals of ten minutes by means of a toothed wheel. By also displacing the axis slightly at each movement of the wheel, the successive star trails fell alongside each other, making a kind of time scale, which made it possible to refer any meteor trail to its position among the stars if the time of its appearance had been noted.

The article is illustrated by a photograph of the instrument in position at the observatory, and one of the successful plates showing a Leonid passing near Mars and the star-cluster Præsepe.

THE TRADE IN TORTOISESHELL.

AMONG the number of misnomers current in popular language, and more especially in that relating to natural history, few are more unfortunate than is the application of the term "tortoiseshell" to the substance which should properly be designated turtleshell, or perhaps rather turtle-skin. It is, however, far too late in the day to attempt a change; tortoiseshell it always has been, and tortoiseshell it will doubtless remain. In its manufactured state, whether in the form of inlaid buhl-work, as the handle of a fan, or as a comb, the translucent plates of tortoiseshell, with their rich mottlings of golden yellow and warm chestnut, are familiar to all. The particular species of reptile, or reptiles, from which it is derived, the part that it plays in the economy of these creatures, and the methods of the manufacture, to say nothing of the enormous volume of the trade, are, however, less matters of common knowledge.

To begin with, tortoiseshell, in the widest sense of the term, may be taken to include the horny superficial plates or shields overlying the bony case of the great majority of tortoises and turtles, although in the popular and trade sense it is restricted to those of the latter. Anatomically it corresponds to the scarf-skin or epidermis of the human integument, the underlying bony case or shell representing, to a great extent, the true skin. Turtles differ from tortoises, among other features, by the heart-shaped form of the upper half of the shell, or carapace, and the conversion of the limbs into paddles adapted for swimming. The upper part of the shell carries a median row of five large superficial horny plates, flanked on each side by a row of four or five still larger flat plates; these thirteen or fifteen large plates, affording some of the most valuable commercial tortoiseshell in the particular species whose "shell" is most in demand. On the front and hind edges of the upper bony shell and the portion connecting the latter with the plastron, or lower shell, are a series of smaller horny plates, generally twenty-four in number, which are sharply bent in the middle, and are known in the trade as "hoof." They form the least valuable portion of commercial tortoiseshell. The under surface of the shell of a turtle carries six pairs of large, more or less flat, horny plates, for which the trade term, derived from their uniform colour, is "yellow-belly." In value they sometimes exceed all but the very finest of the large upper plates, generally known simply as "shell." The term "shell" has thus a very different signification in commerce from that which it bears in natural history, where it is applied to the whole solid case of the reptile, including both the overlying horny plates and the subjacent solid bony structure.

Of the host of land and fresh-water tortoises, most of which are of comparatively small size, the horny plates (which, by the way, are altogether wanting in the so-called soft tortoises of tropical and subtropical rivers), on account of their thinness and opacity, are now of no commercial value whatever, at least in England.

Moreover, it is by no means all the species of marine turtles which yield commercial tortoiseshell. Of these marine turtles, exclusive of the great leathery turtle, which has no horny plates at all, there are three well-marked and perfectly distinct types, severally represented by the green, or edible turtle, the hawksbill, so named from the form of its beak, and the loggerhead. The latter, which is the largest of the three, taking its name from its huge ungainly head. Of the green turtle the plates are so thin and so badly coloured as to be of little or slight manufacturing importance, so that they do not apparently figure at all in the trade circulars of Messrs. Lewis and Peat. In this species the horny plates on the back, which have a dull pale brown ground-colour with streaks of black, meet together by their edges, like the tiles in a pavement, or the plaques in a mosaic. On the other hand, the much thicker and more beautifully-coloured plates on the back of the hawksbill, which afford the most valuable commercial shell, overlap one another like the slates on a roof during the greater part of their owner's life, although in very aged individuals they are joined by their edges. The largest and best plates, which are those in the middle of the sides of the back, are about a quarter of an inch thick in the centre, and measure about thirteen by eight inches; their weight being from about half-a-pound each to as much as one pound. Their translucency and beautifully mottled colours have been already mentioned. The lower plates, or "yellow-belly," on the other hand, are of a uniform golden yellow tint; while the connecting marginal plates, or "hoof," are partly plain yellow and partly mottled. In size the hawksbill is somewhat inferior to the green turtle; the length of the carapace being about thirty-two inches in the former, as against forty-two in full-grown examples of the latter. Both are found in all tropical and subtropical seas; and both resort to flat sandy shores for the purpose of depositing their eggs.

From a dead turtle the plates of tortoiseshell can be readily detached from the underlying bony framework by the application of heat. Sometimes boiling water is used, but more generally the whole shell is placed over a fire. In the West Indies one method, which may or may not be still in use, was to bury the whole shell in the ground for ten or twelve days, when the plates became readily detachable. It is stated, however, that the removal is too often effected by the cruel method of applying heat to the living animal, after which the unhappy turtle is returned to the sea to grow a fresh suit of plates. Formerly it appears to have been the custom to bore each plate of the upper shell, and to fasten together the whole series furnished by each individual turtle with wire or string; such bundles being sold together. Now, however, the samples offered at the London sales on string or wire are comparatively few, although the practice is maintained with Macassar and sometimes Ceylon shell.

In the trade circulars of Messrs. Lewis and Peat, hawksbill tortoiseshell is divided into the following geographical classes, viz.: (1) West India; (2) Zanzibar and Bombay; (3) Mauritius and Seychelles; (4) Singapore and Macasar; (5) Sydney and Fiji; and (6) Ceylon. Most of these classes are again subdivided into "shell," "yellow-belly," and "hoof"; while these latter subdivisions are again split up according to size, thickness, colour, and condition. Nos. 1 and 2 always send very arge imports; next come Nos. 4 and 5, which, however, exhibit very marked seasonal oscillations; while those of Nos. 3 and 6 are much smaller.

In order to ascertain how the trade of the present day in this

commodity compares with that of thirty years ago, reference may be made to some statistics quoted by Dr. P. L. Simmonds in 1878. From these it appears that in the year 1870 the total imports of tortoiseshell (apparently of all descriptions) into the United Kingdom were 49,332 lbs., valued at 32,503*l.* It is also stated by the same writer, that in some years prior to 1878 the amount of the imports had reached the enormous total of thirty tons, with an estimated value of 74,000*l.* In 1870 the average price per pound was between thirteen shillings and fourteen shillings and sixpence; except Indian shell, which was only worth 7*s.* 9*d.* the pound. Dr. Simmonds likewise mentions that whereas about the year 1845 selected samples had realised as much as 3*l.* 3*s.* per pound; between that time and 1870 there had been a great fall in values, although towards the latter date they showed a tendency to rise. For instance, somewhat before that year good coloured shell from Zanzibar and Singapore had fetched from 28*s.* to 29*s.* 6*d.* per pound, and fair to good qualities of West Indian from 31*s.* to 41*s.* the pound.

According to the reports issued by Messrs. Lewis and Peat for 1898, the total amount of hawksbill tortoiseshell (that is to say exclusive of loggerhead shell, which is referred to later on) offered for sale in London during that year was about 76,760 lbs., practically all of which was sold. To arrive at the average price realised at these sales, would involve long calculations without affording any very compensative advantage. Attention may accordingly be directed to certain special values. The highest prices realised during the year were at the May sale, when selected Zanzibar and Bombay shell sold at from 67*s.* 6*d.* to 112*s.* 6*d.* per pound, while two pounds weight of specially selected Sydney and Fiji were disposed of at the rate of 100*s.* per pound. Whether these are record prices, we have no information; but they are certainly ahead of any of those quoted by Dr. Simmonds in 1878, 80*s.* per pound being the maximum value mentioned by him. The next highest price during 1898 was 95*s.* per pound for selected heavy Zanzibar and Bombay shell of a reddish tint, which was disposed of in the September sale. This value is followed by prices ranging between 45*s.*, 62*s.* 6*d.*, and 75*s.* for selected Nassau and Honduras shell in the West Indian class; Jamaica and Havana shell touching, however, as much as 77*s.* the pound. Of West Indian "hoof," the best Nassau and Honduras pale-coloured descriptions realised from 18*s.* to 27*s.* at their top price; while ordinary West Indian was a few shillings cheaper. On the other hand, Zanzibar and Bombay "hoof" ranged between 6*s.* and 17*s.* 6*d.* Some of the highest prices were realised by Nassau and Honduras "yellow-belly," which fetched between 67*s.* 6*d.* and 80*s.* in September, but had fallen to between 45*s.* and 65*s.* per pound by November. "Yellow-belly" is, or was, extensively used by Spanish ladies for large hair-combs, being often much more esteemed for this purpose than the mottled upper shell. Among all the classes of hawksbill tortoiseshell, that from Ceylon seems to have the lowest value; the general quotation being between 14*s.* and 17*s.*, although as much as 34*s.* has been obtained for selected samples.

The tortoiseshell yielded by the loggerhead turtle, of which 8200 lbs. were offered and about 7300 lbs. sold by Messrs. Lewis and Peat during 1898, is a much less valuable commodity than the produce of the hawksbill. During the year in question, the usual price per pound ranged between one and three shillings, although as much as 4*s.* 9*d.* was obtained in March. The upper plates of the loggerhead are much thinner than those of the hawksbill, and of a more or less uniform dark chestnut-brown, without marked translucency.

The statistics quoted above afford a good general idea of the vast extent and value of the London tortoiseshell trade. Unfortunately, it is impossible to give the total British imports and their value, since in the Board of Trade returns tortoiseshell, together with mother-of-pearl, is lumped with other shells, and the value of the mixed imports alone given. In addition to the British trade, the imports of other European countries (although, of course, some of these may have come from Britain) are very large. France, for instance, is a very large importer of tortoiseshell, the average annual amount taken during the ten years ending with 1876 being 42,306 kilogrammes, with a value of 2,078,910 francs. China and Japan are likewise large consumers of tortoiseshell, as is also America. The annual destruction of hawksbill turtles to supply the demand for this shell must therefore be enormous; but since, like most marine creatures, these reptiles are exceedingly prolific, it by no means follows that they are in any imminent danger of extermination.

As regards its employment in the arts and manufactures, tortoiseshell being very similar in its nature to horn, is in like manner made partially plastic before working by immersion in hot water in which salt has been dissolved. The natural curvature of the plates is removed by placing them under pressure between smooth boards while in this semiplastic condition, and allowing them to cool. But, in addition to its plasticity, tortoiseshell possesses the valuable property of welding; so that when a large superficies is required, two or more plates can be readily joined together in this manner. The *modus operandi* is first of all to bevel the adjacent edges of the two plates to be united in opposite directions, and then pressing the overlapping edges together in a metal press under the action of boiling water. So intimate is the union, that when the operation is properly performed, no trace of the division is visible. Nor is this all, for by the application of moist heat tortoiseshell may be made to receive impressions of any form by being squeezed between metallic moulds. Neither are the dust and shavings made in the course of the manufacturing processes useless, for these are placed in brass moulds, where, under moist heat and pressure, they become consolidated into a homogeneous mass of any form that may be desired. Necklaces and many other small fancy articles are made in this manner.

From its high price, it is important to economise as much as possible the material used in the manufacture of tortoiseshell objects. The following ingenious example of this is described by Dr. Simmonds. "In making the frames for eye-glasses, narrow strips of tortoiseshell are used, in which slits are cut with a saw; the slits being subsequently, while the shell is warm, strained or pulled open, until they form circular or oval apertures, by the insertion of tapering triblets of the required shape. The same yielding or flexible property is made use of in the manufacture of boxes, a round flat disc of shell being gradually forced, by means of moulds, into the form of a circular box with upright sides." The only objection to this process is that the colours become so darkened as to be almost black.

In the manufacture of small combs, again, a pair of these are cut out of a single piece of shell by means of a vertical cutter, working in such a manner, that the cores left between the teeth of one comb form the teeth of the other. Similarly in buhl-work cabinets, in which tortoiseshell is inlaid with brass, both portions of the former material cut out by the fret-saw are employed. Hence in a pair of cabinets the pattern of the inlaying is reversed; the tortoiseshell forming the ground-work and the brass the inlaying in one, while in the other the opposite arrangement occurs.

Formerly the manufacture of ladies' combs, especially those made for Spain and South America, formed a very important feature in the tortoiseshell industry, some of these being a couple of feet in width, and from six inches to a foot in height. In England, at any rate, large combs are now disused. Although for veneering purposes, when the colouring of the shell is intensified by a layer of coloured varnish or metallic foil beneath it, thin tortoiseshell is employed; the thick descriptions are those most favoured at the present day in the English market.

Finally, it may be mentioned that on the continent the shell of various species of land tortoises is employed more or less extensively for buhl-work, its colour being always intensified by a substratum of bright foil; and it is said that the same material has occasionally been employed for inlaying purposes in England. Imitation tortoiseshell is made by painting horn with a paste of lime, litharge, and soda, which is allowed to dry and then rubbed off. Dark spots of lead sulphide are thus formed in the horn, giving it a mottled appearance.

R. L.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. W. F. R. Weldon, F.R.S., has been appointed to the vacant Linacre Professorship of Comparative Anatomy, in succession to Prof. Ray Lankester, F.R.S.

Reading College, Reading, has been admitted to the privileges of an affiliated college.

Natural Science scholarships are announced for competition at the following colleges:—Jesus College, on April 18; Merton College, New College, and Corpus Christi College, on June 27.

The Curators of the University Chest have been authorised to guarantee an annual stipend of 100*l.* to a Demonstrator in Mineralogy, and to expend 90*l.* upon sanitary improvements in the Physiological Laboratory.

The annual grant to the Hope Department has been raised from 100*l.* to 110*l.*, and that to the Pitt Rivers Museum from 150*l.* to 200*l.*

The Board of the Faculty of Natural Science has issued new regulations relating to the special subjects of crystallography and mineralogy.

Mr. H. T. Gerrans has been elected a Delegate of the University Museum, and Mr. C. Leudesdorf a Visitor of the University Observatory. Mr. D. R. Wilson has been appointed lecturer in Chemistry at Magdalen College.

The 198th meeting of the Junior Scientific Club was held on Friday, February 24.—Mr. E. H. J. Schuster, New College, read a paper on "The heredity of acquired characters."—Mr. H. B. Hartley, Balliol, read a paper entitled "Notes on the origin of the Japanese." The author held that four waves of population have swept over Japan. The original inhabitants were a race of people who possessed the art of making pottery and lived in holes in the earth, roofed over with branches. These were completely driven out in prehistoric times by the Ainus, to whom the art of pottery making is still unknown. The Ainus were, in their turn, driven northwards or exterminated by an invasion of Mongols from Corea, and the latter now constitute the bulk of the population,—the round-faced type. Later still, apparently a second invasion of Mongols took place, and these, constituting the oval-faced type of Japanese, are now the aristocrats of the land. The antiquity of the first Mongol invasion is plainly evident; it is considered that the early Japanese, up to the fifth century, did not possess the art of writing.

CAMBRIDGE.—Mr. G. W. Walker, of Trinity College, has been elected to an Isaac Newton Studentship in Astronomy and Physical Optics.

The subject for the Adams Prize, 1901, open to all graduates of the University, is "Electric Waves." The successful candidate will receive about 225*l.*

Prof. Lewis has acquired for the Mineralogical Museum the Carne collection of Cornish minerals with their cabinets. The cost (475*l.*) has been almost entirely defrayed by contributions from members of the University and their friends, together with donations from the Clothworkers' and Fishmongers' Companies.

The Museums and Lecture Rooms Syndicate report on the urgent need of new buildings for the department of Botany, and propose that immediate steps be taken for their erection on the site recently assigned by the Senate.

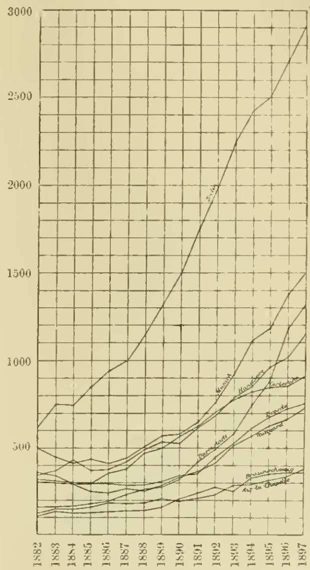
The Antiquarian Committee in like manner press for a new archæological museum, the present building, which was originally but a makeshift, being now utterly inadequate for the valuable ethnological and other collections.

A grant of 300*l* from the Works Travelling Scholars Fund is to be made to Mr. Skeat in aid of his scientific expedition to the Malay Peninsula.

WE understand that there is a vacancy in the Examinations Department of the City and Guilds of London Institute, for the post of assistant to the superintendent, from whom particulars of the appointment may be obtained. Applicants are expected to have graduated, and to have a sound knowledge of some branch of science and educational experience.

A COPY of the Calendar, for 1899, of the University of New Brunswick, Fredericton, has been received. Among the University medals, prizes and scholarships, we notice that a gold medal is offered for competition among undergraduates this year for the best essay on "The aims and methods of modern science." As showing how the alumini help their alma mater, we may mention that the Alumini Association has founded several scholarships and prizes, and that the graduation classes of 1894 and succeeding years have contributed various gifts to the University.

THE steady increase in the number of students who have taken up advanced courses of technical science in Germany during the past fifteen years is shown in the accompanying diagram, reproduced from an article on the new laboratories of the Zürich Polytechnic, contributed to the *Revue Générale des Sciences* by M. Pierre Weiss. There are in Germany nine polytechnics—it is hardly necessary to explain that they are concerned with much more advanced work than our polytechnic institutions—the one having the smallest number of students



Number of students in German Polytechnics every year from 1882 to 1897

being Brunswick, with 363 students, while Berlin, with 2906 students, is the most frequented. The total number of polytechnic students is 10,000. If the average period of study is taken to be three years, the number of trained technical men who become available every year is thus about three thousand. The diagram shows clearly the uniform rise in the number of students of industrial science in all the German polytechnics since about 1886 or 1887.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, February.—Results of meteorological observations at Camden Square (North-west London) for forty years, 1858–97. This is a second series of tables containing the means and other details for each separate year, while the former series contained only the averages, &c., for the whole period. The results now published will be very valuable for reference. The present number contains the observations for January.—Climatological records for the British Empire in 1897. The table contains the results for sixteen representative localities. Most of the extremes have occurred at the same stations in other years. The highest temperature in the shade was 110°·8 at Adelaide, and the lowest −41°·0 at Winnipeg; the former was also the driest station, mean humidity 59, and had the highest temperature in the sun, 166°·3. The dampest station was Esquimalt, mean humidity 86. The greatest rainfall, 83·64 ins., occurred at Grenada, and the least, 14·22 ins., at Malta. Strange to say, Grenada had the least cloud, average amount 2·5. This value is unprecedented in the last twenty-one years, the nearest approach to it being 2·9 at Malta, in 1885.

Wiedemann's Annalen der Physik und Chemie, No. 1.—Susceptibilities of some metals, by E. Seckelson. The magnetic susceptibility of all metals examined is independent of the field in a direction normal to the lines of force.—Structure of the kathode light and nature of Lenard's rays, by E. Goldstein.

Following up his studies of the triple structure of the kathode light, the author finds that the third kathode layer consists of rectilinear rays, which, however, do not proceed from the kathode itself, but from every point along the path of a ray of the second layer. They are produced, so to speak, by a diffused reflection produced at the surfaces of the gaseous particles. If K_2 rays impinge upon a solid substance, reflected kathode rays are produced. If the solid is thin enough, some of the rays penetrate it, and we have Lenard rays on the other side.—Measurement of very small induction coefficients, by H. Martienssen. The method used depends upon the phase displacement produced by the self-induction in question upon an alternating current. Coefficients down to a few thousand cm. are thus easily measured, the inferior limit hitherto attained having been 10^6 cm.—Air resistances determined by means of a new rotation apparatus, by O. Mannesmann. Discs are mounted at the end of a horizontal arm, and are turned about a vertical axis by means of a water-power or electric motor. The air resistance encountered by them is indicated by enabling the disc to slide backwards in its mounting, in a direction contrary to the direction of motion. In sliding back it pulls a string which passes over a pulley on the axis of rotation, and supports a weight which is thus pulled up. The amount of raising is indicated by an aluminium pointer on a scale. Thus the amount of air resistance can be read off at any instant. The author finds that warm air offers, if anything, a greater resistance than cold air. The resistance encountered by a perforated surface is smaller in proportion to its remaining surface than an unperforated surface This fact has a practical application to sailing practice.—A new type of volumenometers, by A. Oberbeck. Two parallel glass tubes ending in glass vessels are fixed side by side on a board which can be tilted to any desired angle. The vessels have ground edges, and can be hermetically closed by means of greased glass plates. The tubes join at the other end and communicate with a reservoir of mercury. On closing the vessels and lowering the other end, the mercury columns descend by equal amounts in the two tubes. But if the body whose volume is to be determined is previously inserted in one of the vessels, the mercury in the corresponding tube does not descend as far as before. The author shows how to calculate the volume of the body from the data thus obtained.

SOCIETIES AND ACADEMIES.

London.

Royal Society, January 26.—"On the Nature of Electrocapillary Phenomena. I. Their Relation to the Potential Differences between Solutions." By S. W. J. Smith, M.A. Communicated by Prof. A. W. Rücker, Sec. R.S.

The discrepancy between the Helmholtz theory of the capillary electrometer and the Nernst-Planck theory of the potential differences between solutions is discussed in this paper. A detailed examination of the relation between the phenomena from which the discrepancy arises, shows that these phenomena serve to corroborate the Nernst-Planck theory, and that they further throw considerable light upon the nature of electrocapillary phenomena.

It is shown that if the Nernst-Planck theory be true, the surface tension variation in the "descending" branches of the capillary electrometer curves is not solely due to an electrostatic effect of the kind discussed by Helmholtz; but that there is a further effect, dependent upon the nature and concentration of the solution employed in the electrometer.

The extent to which the Helmholtz theory may be true is discussed. It is concluded that this theory only suffices, in general, to give the variation in the potential difference at the capillary electrode. Whether the assumption is ever true, that the potential fall at the capillary electrode is zero when the maximum surface tension is reached, will depend upon whether there is any case for which, when the potential difference between the solution and the capillary electrode is very small, the non-electrostatic effect upon the surface tension can be neglected.

The non-electrostatic effect in the "descending" branch would appear to be practically independent of the nature of the anion, while that in the "ascending" branch is probably for the most part independent of the nature of the kation. Experiments have been made with the object of determining quantitatively the manner in which the surface tension variation depends upon the chemical nature and concentratinn of the solution, and the conditions under which such dependence may become negligible. The nature of these experiments is indicated in the paper.

February 2. "On the Effects of Strain on the Thermo-Electric Qualities of Metals." By Magnus Maclean, M.A, D.Sc. Communicated by Lord Kelvin, F.R.S.

1. Seebeck (*Pogg. Ann*, 1826) discovered the great effect that hardness, or softness, or crystalline structure, has on the thermo-electric properties of metals. Magnus made a number of experiments by winding a hard-drawn wire on a reel. Parts of this wire were softened and annealed. When heat was applied to the parts of the wire which were between unannealed and annealed, a thermo-electric current was obtained. In this way Magnus found that the current passed from soft to hard through the hot junction for silver, steel, cadmium, copper, gold, and platinum; and that it passed from hard to soft through the hot junction for German silver, zinc, tin, and iron.

2. Lord Kelvin describes, in vol. ii. of his "Mathematical and Physical Papers," a number of qualitative experiments to determine the direction of thermo-electric currents in the same metal when one part of it is left unstrained, and the other is—

(1) Permanently affected by application and removal of longitudinal stress;
(2) Permanently affected by application and removal of lateral pressure;
(3) Under a longitudinal stress (*a*) within its limits of elasticity, and (*b*) beyond its limits of elasticity;
(4) Hardened by twisting;
(5) Annealed.

3. He showed that for iron and copper permanent longitudinal extension gave the same effect as permanent lateral contraction; and that this effect for both was opposite to that experienced by them when under a stress which caused a temporary strain. Thus for a copper wire under a longitudinal stress the current was from the strained copper to the free copper across the hot junction, and the magnitude of the current increased with the increase of the longitudinal stress. If the stress were removed and the wire left with a permanent strain, the current was now from the free copper to the strained copper through the hot junction. Similar results were got with iron, only the direction of the current was in each case opposite to the direction of the current in the corresponding case for copper. The highest temperature used in these experiments was about 100° C.

4. To determine the *magnitude* of the thermo-electric effects obtained from any one metal, strained and unstrained, was the object in view in these experiments.

The metals so far tried are:—

(1) Copper wire from Messrs. Johnson and Matthey. This was pure electrotype copper wire with no impurity detected except an unweighable trace of iron.
(2) Copper wire, ordinary commercial, from Messrs. Johnson and Matthey. This was analysed[1] in the chemical laboratory of the University, and was found to contain:—

Copper	...	99·4 per cent.
Arsenic	..	0·44 per cent.
Lead	...	0·08 per cent.
Bismuth	..	trace.
		99·92 per cent.

(3) Copper wire, used for alloying with gold and silver, from Messrs. Johnson and Matthey. This also was analysed, and it contained 99·85 per cent. of copper.
(4) Copper wire from Glover. Chemical analysis showed that it contained 98·35 per cent of copper.
(5) Copper wire of Glover's manufacture, and supposed to be soft, and to have a very high conductivity. It contained 99·08 per cent. of copper and 0·22 per cent. of lead.
(6) Copper wire used in laboratory experiments. It contained 98·51 per cent. of copper.
(7) Lead wire, commercial. It contained 98·9 per cent. of lead.
(8) Lead wire, pure.[2] It contained 98·97 per cent. of lead.

[1] All the chemical analyses stated in this paper were given by Mr. Anderson, of the Chemical Laboratory of this University.

[2] These specimens of commercial and pure lead wires were obtained from Messrs. Baird and Tatlock of Glasgow. Other specimens have been ordered elsewhere for a fresh determination.

(9) Platinoid wire obtained from Messrs. Glover.
(10) German silver wire obtained from Messrs. Glover.
(11) Reostene[1] wire obtained from Messrs. Glover.
(12) Manganin wire obtained from Messrs. Glover.

5. The size of the wire used, except for (5) (7) (8) above, was about No. 18 standard gauge. A piece of the wire was taken and drawn through a draw plate till it was reduced to about No. 24 standard gauge. This process of wire drawing subjects the wire to longitudinal extension and to lateral compression. Lord Kelvin in his experiments ("Mathematical and Physical Papers," vol. ii., and section 3 above) showed that thermo-electric differences were in the same direction for longitudinal extension and transverse compression. For drawn and undrawn wires the direction of the current through the hot junction is from *undrawn to drawn* for copper, reostene, and lead, and from *drawn to undrawn* for platinoid, German silver, and manganin. The magnitude of the thermo-electric difference per degree difference of temperature is given in the following table:

Metal	Resistance in international ohms of 60 cm. of wire		Total resistance external to galvanometer	Total resistance in circuit	Thermo-electric difference in mikrovolt per degree of difference of temperature up to 100° C.
	Undrawn	Drawn			
Copper, Johnson & Matthey, No. 1 ...	0·0086	0·0462	0·0548	1·555	0·0089
Ditto, No. 2 ...	0·0239	0·1254	0·1493	1·649	0·0460
Ditto, No. 3 ...	0·0095	0·0536	0·0631	1·563	0·0163
Copper, hard, Glover	0·0091	0·0523	0·0614	1·561	0·0106
Copper, soft, Glover	0·0155	0·0417	0·0572	1·557	0·0483
Copper, laboratory	0·0089	0·0431	0·0520	1·552	0·0675
Lead, pure ...	0·1088	0·5043	0·613	2·113	0·0184
,, commercial.	0 1123	0·5517	0.664	2·164	0·0273
Reostene	0·4058	1·831	2·237	3·737	0·6465
Platinoid	0·2186	1·052	1·271	2·771	1·477
German silver ..	0·1673	0·845	1·013	2·513	0·2638
Manganin... ...	0·212	1·008	1·220	2·720	0·0843

6. The effect of hardening by twisting has been partially tried. Thus two pieces of laboratory copper wire were taken, and one was in successive experiments twisted 1 turn, 3 turns, 5 turns, 7 turns, 8½ turns per cm. The wire with 8½ turns per cm. got quite brittle, and broke when an attempt was made to put more twists into it. The twisted wire was then heated red-hot by an electric current, and allowed to cool. This partially annealed it.

The results are given in the following table:—

Number of turns in twisted wire per centimetre.	Thermo-electric difference between untwisted and twisted copper wire in mikrovolt per degree.
1	0·0054
3	0 0223
5	0·0262
7	0·0419
8·5	0·0594
8·5 and partially annealed ...	0·0345

7. The effects of twist on the drawn copper wire were also tried, and it was found that 1, 2, 3 turns per cm. in the drawn wire slightly diminished the thermo-electric difference obtained between the undrawn wire and the drawn wire; but that 4 and 5 turns per cm. in the drawn wire gave the same thermo-electric difference as was found between the undrawn wire and the untwisted drawn wire.

8. The drawn and twisted copper wire was annealed by putting a gradually increasing current through till it got red-hot, and then, without breaking the circuit, the current was gradually reduced till the wire was at the temperature of the laboratory. Trying it in this condition along with the undrawn and untwisted copper wire, the current through the hot junction was found to be reversed, being from the drawn twisted and annealed wire to the undrawn wire. The thermo-electric difference was 0·0081 mikrovolt per degree.

9. Similar experiments on platinoid wires as those described in Section 7 on copper wires gave similar results. Thus 1, 2, 3 turns per cm. in the drawn platinoid wire diminished the thermo-electric difference obtained between the drawn wire and the undrawn wire; but 4 and 5 turns per cm. in the drawn wire gave the same thermo-electric difference (1·477 mikrovolts per degree) as was found between the untwisted drawn wire and the undrawn wire.

10. The drawn and twisted platinoid wire was partially annealed, and the thermo-electric difference between it and the undrawn platinoid wire was thereby reduced from 1·477 mikrovolts per degree to 0·567 mikrovolt per degree.

11. A beginning has been made of determining the thermo-electric differences between free wires and wires previously permanently elongated 1, 2, 3, &c., per cent. by a simple longitudinal stress; also wires while (*a*) under stress, stretching them within their limits of elasticity; and (*b*) under stress, stretching them beyond their limits of elasticity.

[1] Reostene belongs to the nickel steel group, with certain other metals as an alloy.

February 9.—"On the Recovery of Iron from Overstrain." By James Muir, B.Sc., Trinity College, Cambridge (1851 Exhibition Science Research Scholar, Glasgow University). Communicated by Prof. Ewing, F.R.S.

It is known that iron which has been overstrained in tension—that is to say, strained beyond the yield-point so that it suffers a permanent stretch—possesses different elastic properties from the same iron in its primitive condition. Ultimately, the material is "hardened" by stretching, its elastic limit being raised and its ductility diminished; but first of all very imperfect elasticity is exhibited, and the elastic limit may be found to be reduced to zero. The material, in fact, assumes a semi-plastic state; so that a stress-strain curve obtained from a recently overstrained bar of iron or steel, shows a marked falling away, even for small loads, from the straight line which would indicate obedience to Hooke's law.

It is the recovery from this semi-plastic state induced by overstrain to a condition of perfect or nearly perfect elasticity with raised elastic limit, that is referred to in the title of this paper. Such recovery is known to be effected by mere lapse of time.

This slow recovery of elasticity with lapse of time is first illustrated in the paper by means of stress-strain curves obtained at succeeding intervals of time. Recovery under continued stress is next considered, and the marked hysteresis in the relation of extension to load, exhibited by overstrained iron, is illustrated by means of a closed cycle. It is then shown that by exposing an overstrained specimen of iron or steel for three or four minutes to a temperature of 100° C, a very perfect restoration of elasticity is effected; in the case of semi-mild steel, a more perfect restoration than was brought about by a fortnight's rest at the normal atmospheric temperature. So moderate a temperature as 50° C. is also shown to have a large influence in hastening recovery from overstrain.

It is next shown that by striking a recently overstrained specimen with a hammer so as to make it ring, the material of the specimen becomes less elastic. That is, the effect of mechanical vibration is opposite to that of increase of temperature.

The influence of magnetic agitation was also tried, but with a coil giving a field strength of 140 C.G.S. units at its centre, no effect was found to be produced on the elastic condition of recently overstrained material; the process of recovery seemed to be neither accelerated nor retarded.

Compression experiments are also described in the paper; an instrument specially designed by Prof. Ewing having been employed to measure the small compressional strains. The semi-plasticity of recently overstrained iron is thus shown, and the effect of moderate temperature in restoring elasticity demonstrated, by means of compression curves. The lowering of the compression yield-point which accompanies the raising of the tension one (due to tensile overstrain) is also indicated.

Physical Society, February 24.—Prof. Perry, F.R.S., Vice-President, in the chair.—A paper by Mr. E. F. J. Love, on the Joule-Thomson effect and its connection with the characteristic equation, and some of its thermo-dynamical consequences, was read by Mr. Watson. The author points out that the results of the original Joule-Thomson investigation of the thermal effects of fluids in motion has been utilised hitherto almost exclusively for the one purpose of determining the relation between various gas-thermometer scales and the absolute scale of temperature. He proceeds to deduce further consequences from those results, indicating the relation between the formula assigned to the Joule-Thomson effect, regarded as a

function of temperature, and the particular form adopted for the characteristic equation of a gas. He further attempts to supply a theoretical basis to the various formulæ of Van der Waals, Rose-Innes, and others, at the same time insisting upon a very high degree of accuracy for the original experimental work of Joule and Thomson. Then follows a discussion of the relation between the intrinsic energy of a gas and its volume, and a method is given for calculating the ratio of the principal two specific heats of a gas. Lastly, the author considers some points in the thermodynamics of substances at their temperature of maximum density. It is shown that (1) the Joule-Thomson effect for every substance at maximum density is zero; just as it is, though for a different reason, in the case of an ideal perfect gas. And (2) that the infinite number of specific heats possessed by every substance are, at the temperature corresponding to maximum density, reduced to one specific heat. Mr. Rose-Innes congratulated the author on having written an interesting paper on a difficult subject. At the same time he felt bound to acknowledge that he was out of sympathy with the general idea contained in the paper. The experimental difficulties that occurred in carrying out the Joule-Thomson investigation were so enormous, that it was better to rely on them as little as possible, notwithstanding the great skill of the experimenters. The Joule-Thomson results could not be disregarded altogether, since they were necessary for the establishment of the thermodynamic scale; but once that scale had been set up, it was better to have recourse as much as possible to such experiments as those of M. Amagat on the compressibility of gases. He also pointed out that one of the deductions given in the paper from Van der Waals's formula, had already been given by Van der Waals himself.—Mr. Watson replied, and the Vice-President proposed a vote of thanks to the author for his valuable paper.—The meeting then adjourned until March 10.

Chemical Society, February 16.—Prof. Dewar, President, in the chair.—The following papers were read:—On the absorption spectrum and constitution attributed to cyanuric acid, by W. N. Hartley. The author attributes his previous observation of an absorption band in the spectrum of cyanuric acid between wave-lengths 2747 and 2572 to impurity in the specimen examined. — A study of the absorption spectra of isatin, carbostyril and their alkyl derivatives in relation to tautomerism, by W. N. Hartley and J. J. Dobbie. A very close resemblance is observed between the molecular absorption curves of carbostyril and methyl- and ethyl-pseudocarbostyril, and also between those of isatin and methylpseudoisatin; this indicates that all these substances have the lactam constitution. The absorption spectra of methylcarbostyril and methylisatin differ greatly from those of carbostyril and isatin respectively.—The estimation of nitrites and nitrates by means of ferrous chloride, by A. W. Blyth. On addition of ferrous chloride, solutions of nitrites immediately yield nitric oxide; with solutions of nitrates, however, one to two minutes elapse before nitric acid is evolved. Applying these facts the author has devised an apparatus for estimating nitrites and nitrates, either singly or together, as nitric oxide.—Estimation of boric acid mainly by physical processes, by A. W. Blyth. The author uses the well-known increase of the specific rotation of tartaric acid which occurs on adding boric acid, in estimating the latter. On boiling boric acid with sodium carbonate solution, reaction occurs in accordance with the following equation:—

$$Na_2CO_3 + 4H_3BO_3 = Na_2B_4O_7 + CO_2 + 6H_2O;$$

on employing certain precautions the reduction in electrical resistance yields the necessary data for estimating the boric acid used.—The interaction of ethylic sodiomalonate and mesityl oxide, by A. W. Crossley.—On Lossner's benzoylethyloxysulphocarbamic acid and the formation of pseudoureas, by A. E. Dixon. It is shown that the substance regarded by Lössner as benzoylethyloxysulphocarbamic acid COPh.NEt.CO.SH, has the constitution COPh.NH.CS.OEt; the supposed benzoylethylurea COPh.NEt.CO.NH_2 obtained from it is a pseudourea of the constitution COPh.N:C(OEt)NH_2. On certain isomeric tertiary benzylthioureas, by A. E. Dixon. Is camphene unsaturated, by J. E. Marsh.—Formation of α-pyrone compounds and their transformation into pyridine derivatives, by S. Ruhemann.

Entomological Society, February 15.—Mr. G. H. Verrall, President, in the chair.—Mr. B. A. Bower exhibited perfectly black, melanic examples of *Boarmia abietaria*, Hb., bred from ova laid by a female of the ordinary Box Hill form, which was captured on July 9, 1897. They were part of a brood of seventeen, seven of which were of the black aberration; and for comparison with them, he showed specimens from Box Hill, South Devon and the New Forest. Mr. Blandford exhibited some small lumps of common salt burrowed by larvæ of *Dermestes vulpinus*, to which he had incidentally referred in a letter appearing in Nature. He had on various occasions called attention to depredations of *Dermestes vulpinus*, arising from a habit the larvæ had of burrowing through different materials in order to find a shelter in which to undergo pupation, though this was the first time that salt, as a substance attacked in that way, had come under his notice. Mr. J. J. Walker said he believed one of the earliest references to injuries caused by *Dermestes* was to be found in "The Last Voyage of Thomas Candish," where there was an interesting account of certain worms which, bred from a stock of dried penguins, proceeded to devour the whole of the ship's stores and then to gnaw into the timbers, creating great alarm lest the ship should spring a leak. This voyage took place in the year 1593; and the worms, he thought, could only have been the larvæ of *Dermestes vulpinus* or some closely allied species.—Dr. T. A. Chapman read a "Contribution to the life-history of *Micropteryx* (*Eriocephala*) *ammanella*, Hubn."

Cambridge.

Philosophical Society, February 6.—Mr. J. Larmor, President, in the chair.—On the inheritance of variation in the corolla of *Veronica Buxbaumii*, by Mr. W. Bateson and Miss D. F. M. Pertz. In a former paper (*J. Linn. Soc.*, xxviii.) it was shown that in *Veronica Buxbaumii* there is commonly a high percentage of variation in the form of the corolla. Certain symmetrical forms having two posterior petals, two anterior petals, or three petals, respectively, are especially abundant. The frequency of these forms and of other forms of corolla has since been observed continuously in the case of certain chosen plants during the period of flowering. The statistics thus obtained are given in the present paper. A special attempt was made to determine whether any difference occurs between offspring raised from seed produced in normal and abnormal flowers borne by the same plant, both being alike self-fertilised. So far as the experiments went there was no evidence that such a difference exists. There is very great difference in the percentage of abnormal corollas borne by different individuals raised from the same self-fertilised capsules; and after the self-fertilisation had been continued for four generations the same absence of uniformity persisted. But in the offspring both of normal and abnormal flowers the percentage of abnormality found in the family to which the parent belonged was on the whole maintained.—On the anatomy of a supposed new species of *Coenopsammia* from Lifu, by Mr. J. Stanley Gardiner. The skeletoglœa, or structureless lamella, is directly attached to the corallum at the bases of the mesenteries and of the dividing walls of the cœnosarcal canals by fibrillated bundles. These were shown to be identical with the calicoblasts of von Heider, and it was contended that the corallum is formed completely outside the animal. It was further contended that the stomodæum together with the mesenterial filaments is homologous with the whole gut of the Triploblastica, and that the so-called endoderm is homologous with the mesoderm. The Actinozoon polyp then must be regarded as a Triploblastic form.

Dublin.

Royal Dublin Society, January 18.—Prof. G. F. Fitzgerald, F.R.S., in the chair.—Mr. J. Holms Pollok read a paper on the large deposits of kieselguhr, or diatomaceous earth, in the county of Antrim. They occur on both banks of the lower Bann, and are of exceptional purity just at the point where the Bann emerges from Lough Neagh. Analysis shows the kieselguhr to be of good quality and suited for many industrial purposes. It is seen under the microscope to be composed of little cubical box-shaped diatoms, with a few of radial and elongated shapes. It is not suited for making dynamite, but it makes an excellent non-conducting lining for safes and refrigerators, and could be used for covering boilers and steam-pipes. As kieselguhr is made up of the siliceous remains of low forms of aquatic plants, it is in the highest degree probable that the whole bottom of Lough Neagh is covered with such a deposit; and if this be the case, it would be a very valuable addition to the economic resources of Ireland.—Sir Howard Grubb, F.R.S., read a paper in which he suggested

the utilisation of the "Marconi" system of wireless telegraphy for the control of public and other clocks, and explained how this could be effected. He also communicated a note upon the results that may be expected from the proposed monster telescope at the Paris Exhibition of 1900.—Prof. T. Preston, F.R.S., made a communication upon the perturbations suffered by the spectral lines in a strong magnetic field. The various types of effect were explained by theory, and a general law, which appears to govern all the phenomena, was laid before the Society.—Prof. J. Emerson Reynolds, F.R.S., exhibited the new Geissler tube, illustrating the beautiful colour-effects obtained under the kathode rays, and Prof. T. Johnson showed a series of specimens of rubber-producing plants and their products in various stages of manufacture.

EDINBURGH.

Royal Society, January 23.—Sir Arthur Mitchell, K.C.B., in the chair.—Lord McLaren presented a communication on the symmetrical solution of the ellipse-glissette elimination problem.—Prof. Cossar Ewart read a second instalment of his experimental contributions to the theory of heredity, in which facts and theories of reversion were taken up in considerable detail. The question was as to how far the resemblance of offspring to a recent or remote ancestor was a mere coincidence, or due to chance, or governed by what may be termed the law of reversion. Instances were very familiar in which the offspring, instead of displaying characteristics intermediate to those of the parents, strongly resembled one or other, or some grandparent, or even a more remote ancestor. Thus, it was a notorious fact that the children of mulattoes varied greatly, some being almost white, while others were darker than their parents. This was clearly a case of reversion. The mental, moral and physical peculiarities of many half-castes might also be explained as being due to reversion, to which there was a strong tendency when the parents belonged to two distinct types of race.

February 6.—Lord Kelvin in the chair.—Prof. Crum Brown, in a note on Nernst's "osmotic experiment," in which a water septum fixed in bladder separates pure ether from a solution of benzol in ether, gave what seemed to him the simple explanation of the phenomenon in terms of diffusion as determined by the gradient of concentration, and described and exhibited a new form of experiment in which the semi-permeable septum moved up as osmosis proceeded. A sufficiently dense solution of calcium nitrate was separated from a solution of phenol in water by a layer of phenol. As the water diffused through from above, the layer of phenol gradually rose. Basing on his view of the action, Prof. Crum Brown gave a new definition of osmotic pressure which had the merit of being purely experimental without any reference to molecular theories. This definition was to the effect that if two solutions of a given substance are formed at different pressures, they will be of the same concentration when this difference of pressure is equal to the osmotic pressure. Prof. Crum Brown also gave an account of an old proposal of the late Prof. Andrews as to the nomenclature of the anhydrides of acids. The proposal was to use carbonica, sulphurosa, sulphurica, as the ordinary every-day names of CO_2, SO_2, SO_3, which are often erroneously called *acids*, and have other more technical but less convenient names. These names would fall into line with such old familiar words as silica, soda, lithia, &c.—Lord Kelvin read a paper on the application of Sellmeyer's dynamical theory to the dark lines D_1 D_2 produced by vapour of sodium. It was suggested by Becquerel's recent discovery of anomalous dispersion in sodium vapour, the broadening out of the D lines being indicated by Sellmeyer's theory when worked out for a dynamical system of two concentric spherical atoms enclosed in an ether sheath.—In a second communication Lord Kelvin gave some additional theorems on the motion of liquid in an ellipsoidal hollow—a continuation of his paper on the same subject of 1885. One result referred to the great force required to keep the prolate ellipsoid fixed in position when the axis of molecular rotation was inclined at an angle of 45° to the principal axis of figure.—Messrs. A. J. Herbertson and P. C. Waite read a paper on the mean annual rainfall of Australia, being Part I. of a series of papers on the rainfall of Australasia. The results, which cover a period of fifteen years from 1881–95 inclusive, were shown on charts. In years of drought (*e.g.* 1888) about three-quarters of the whole continent had a rainfall of less than 10 inches per annum; but in years of heavy rainfall (such as 1893–94) this region was much diminished in area. The 10-inch line was the limit of sheep-rearing; the 15-inch line, of wheat-growing; the 25-inch line, of maize; and the 40-inch line, of sugar-cane.—Dr. Thomas Muir presented a communication on the multiplication of an alternant by a symmetrical function of the variables.

February 9.—Prof. Copeland in the chair.—At the request of the Council, Vice-Admiral Makaroff, of the Imperial Russian Navy, gave an address on some important oceanographic problems and novel modes of research. He exhibited his own forms of hydrometer and thermograph for ocean work, and described some of the more important results he had obtained in regard to temperature and salinity of the ocean. For example, the isotherms of the surface waters in Formosa Channel run parallel to the mainland, and in certain months the change of temperature is so rapid as we pass across the strait that a seaman could use temperature readings as a guide for steering his craft. A large model was exhibited of the Admiral's "ice-breaker," *Ermack*, which has just been completed to his design by Armstrong, Whitworth, and Co., of Newcastle. There were three screw-propellers in the stern, and also a screw in front for "breaking" the ice. There were special arrangements for moving 150 tons of water from one end of the ship to the other, and for moving 100 tons of water from one side to the other, thus enabling the navigator to change the lie of the ship at will. One of the practical ends for which the ship had been designed was to clear the Kara Sea of ice in early summer, so as to facilitate approach to the Obi and Yenisei Rivers. If this were successfully accomplished, then in all probability a trip to the North Pole would be attempted.

Mathematical Society, February 10.—Dr. Morgan, President, in the chair.—The following papers were read:—The eight queens' problem, by Dr. Sprague; on a problem of Lewis Carroll's, by Prof. Steggall.

PARIS.

Academy of Sciences, February 20.—M. van Tieghem in the chair.—The work of the soil, by M. P. P. Dehérain.—An experimental study of the relations existing between the state of aeration, and capacity of holding water possessed by a soil and plant growth.—Heat effects produced by stretching india-rubber, under conditions which may be realised for the elasticity of a muscle under contraction, by M. A. Chauveau.—Estimation of carbon monoxide, by M. Armand Gautier. A reclamation of priority in reply to some remarks by MM. Schlagdenhauffen and Pagel.—Some remarks on the claim to priority by M. J. Winter on the cryoscopy of urine, by M. Ch. Bouchard.—On the growth of functions defined by differential equations, by M. Emile Borel.—On divergent series and functions defined by a Taylor's series, by M. Le Roy.—On some forms of differential invariants, by M. Emile Cotton.—On the coefficient of expansion characteristic of the perfectly gaseous state, by M. Daniel Berthelot. From a comparison of the results of Amagat and Regnault, the author concludes that the limiting value of the coefficient of expansion of hydrogen is ·0036625 when the pressure is indefinitely reduced, and hence that the absolute zero is $-273^\circ{\cdot}04$ C.—On the complex oxides of the rare earths, by MM. G. Wyrouboff and A. Verneuil. Although the ceroso-ceric oxide is quite insoluble in nitric acid, it dissolves very easily when mixed with a certain quantity of lanthanum or didymium oxides. In the present paper the authors have investigated the limits between which the foreign oxides possess this peculiar property, and find that the percentage may vary between 10 and 43 per cent. These results are attributed to the formation of complex oxides of the type $Ce_3O_4 . MO$.—Action of oxidising agents upon some amides, by M. Œchsner de Coninck.—On the law of dilution of electrolytes, by M. P. Th. Muller. The difference between the molecular conductivity μ and that at infinite dilution μ_∞ was shown by Oswald to be a function of the volume only. According to the author, if $\delta = \mu_\infty - \mu$, then when the volume $v = 2^n$, the expression for δ is of the form $\delta = A\left(\frac{3}{4}\right)^n$, A being a constant. From this is deduced a formula for molecular conductivities of neutral salts formed of monovalent ions, $\mu = \mu_\infty - 52{\cdot}72\ v^{-(0{\cdot}41504)}$.—On a new method of preparing mixed alkyl-phenolic phospheric ethers, by M. Albert Morel. The mixed ethers are prepared by acting upon $PO(OC_6H_5)_3$ with sodium ethylate.—Action of fermentation amyl alcohol upon its sodium derivative, by M. Guerbet.

In the use of boiling amyl alcohol and sodium as a reducing agent, it was found that the regenerated amyl alcohol had its boiling point raised. This was found to be due to the presence of a new alcohol, $C_{10}H_{22}O$, and its isovaleric ether. A second acid of the composition $C_{10}H_{20}O_2$ is also produced in the same reaction. Distribution of carbon in humic materials, by M. G. André.—On the embryogeny of *Stoecharthrum Giardi*, by MM. Maurice Caullery and Félix Mesnil.—Contribution to the study of elements peculiar to the general cavity of the Phymosome, by MM. J. Kunstler and A. Gruvel.—On the earthquake at Triphylie of January 22, by M. D. Eginitis.

DIARY OF SOCIETIES.

THURSDAY, MARCH 2.

ROYAL SOCIETY, at 4.30.—Perturbations of the Leonids: Dr. G. J. Stoney, F.R.S., and Dr. Downing, F.R.S.—On Flapping Flight of Aeroplanes: Prof. M. F. Fitzgerald.—On Hydrogen Peroxide as the Active Agent in producing Pictures on a Photographic Plate in the Dark: Dr. Russell, F.R.S.
ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.
LINNEAN SOCIETY, at 8.—On the External Nares of the Cormorant: W. P. Pycraft.—On the Irish *Carex rhynchophysa*: G. C. Druce.—On the Fertilisation of *Glaux maritima*, Linn.: Edward Step.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Wireless Telegraphy: G. Marconi.
CHEMICAL SOCIETY, at 8.—Bromomethylfurfuraldehyde: H. J. H. Fenton and Mildred Gostling.—The Action of Metallic Thiocyanates on certain Substituted Carbamic and Oxamic Chlorides, and a New Method for the Production of Thiobiurets: Dr Augustus Edward Dixon.—Ethylic ββ Dimethylpropane Tetracarboxylate: W. Trevor Lawrence. The Action of Alkyl Iodides on Hydroxylamine: Prof. Wyndham R. Dunstan, F.R.S., and Ernest Goulding.

FRIDAY, MARCH 3.

GEOLOGISTS' ASSOCIATION, at 8.—Honeycomb and other Forms of Surface Weathering of Sandstone and Limestone: George Abbott.
QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, MARCH 4.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S.

MONDAY, MARCH 6.

SOCIETY OF ARTS, at 8.—Cycle Construction and Design: Archibald Sharp.
VICTORIA INSTITUTE, at 4.30.—The Nature of Life, Part II.: Prof. Lionel Beale, F.R.S.

TUESDAY, MARCH 7.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.
ZOOLOGICAL SOCIETY, at 8.30.—Exhibition and Remarks upon Specimens of the *Medusa* of Lake Tanganyika: J. E. S. Moore.—On the Chimpanzees and their Relationship to the Gorilla: Dr. A. Keith. On the Myology of the Edentata: Dr. C. A. Windle and Prof. P. G. Parsons.
INSTITUTION OF CIVIL ENGINEERS, at 8.—Water-Tube Boilers for Marine Engines J. T. Milton.—Recent Trials of the Machinery of War-Ships: Sir. A. J. Durston, K.C.B., R.N., and H. J. Oram, R.N.—Monthly Ballot for Members.

WEDNESDAY, MARCH 8.

SOCIETY OF ARTS, at 8.—Cornish Mines and Miners: J. H. Collins.
GEOLOGICAL SOCIETY, at 8.—On the Evolution of the Genus *Micraster*: A. W. Rowe.—On a Sill and Faulted Inlier in Tideswell Dale (Derbyshire): H. H. Arnold-Bemrose.

THURSDAY, MARCH 9.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: A Preliminary Note upon certain Organisms isolated from Cancer, and their Pathogenic Effects upon Animals: H. G. Plimmer.—On the Gastric Gland of Mollusca and Decapod Crustacea: its Structure and Functions: Dr. MacMunn.
SOCIETY OF ARTS (Indian Section), at 4.30.—Leprosy in India: H. A. Acworth.
MATHEMATICAL SOCIETY, at 8.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8. Subject announced at Meeting of March 2.

FRIDAY, MARCH 10.

ROYAL INSTITUTION, at 9.—Measuring Extreme Temperatures: Prof. H. L. Callendar.
ROYAL ASTRONOMICAL SOCIETY, at 8.
PHYSICAL SOCIETY, at 5.—(1) A Study of an Apparatus for the Determination of the Rate of Diffusion of Solids dissolved in Liquids; (2) Note on the Source of Energy in Diffusive Convection: Albert Griffiths. An Exhibition of Dr. A. Wehnelt's Electrolytic Current Interruptor for Ruhmkorff Coils: A. A. Campbell Swinton.
INSTITUTION OF CIVIL ENGINEERS, at 8.—The Construction of the Elan Aqueduct. Birmingham Waterworks: H. Lapworth.
MALACOLOGICAL SOCIETY, at 8.

SATURDAY, MARCH 11.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Telegraphy: W. H. Preece and J. Sivewright, 15th edition (Longmans).—The Tutorial Dynamics: W. Briggs and G. H. Bryan (Clive).—Matriculation Directory, January (Clive).—Verhandlungen der Deutschen Zoologischen Gesellschaft auf der Achten Jahresversammlung zu Heidelberg den 1 bis 3, Juni 1898: Prof. J. W. Spengel (Leipzig, Engelmann).—Calendar, &c., of the Department of Science and Art, 1899 (London).—The Science of Life: J. A. Thomson (Blackie).—Allgemeine Biologie: Dr. M. Kasswitz, Zweiter Band (Wien, Perles).—Practical Work in Physics: W. G. Woollcombe, Part 4 (Oxford, Clarendon Press).—Die Medial-Fernrohre: Prof. L. Schupmann (Leipzig, Teubner).—Vertebrate Remains from the Port Kennedy Bone Deposit: E. D. Cope (Philadelphia).—Cambridge Natural History. Vol. ix. Birds: A. H. Evans (Macmillan).—The Chemistry of Coke: O. Simmersbach, translated, &c., by W. C. Anderson (Glasgow, Hodge).—Practical Dictionary of Electrical Engineering and Chemistry: P. Heyne (Grevel).—History of the New World called America: E. J. Payne, Vol. 2 (Oxford, Clarendon Press).—L'Audition et les Organes: Dr. M. E. Gellé (Paris, Alcan).—La Céramique Ancienne et Moderne: E. Guignet and E. Garnier (Paris, Alcan).—Recueil de Données Numériques, Optique, Deux. Fasc. (Paris, Gauthier-Villars).—Lectures on Theoretical and Physical Chemistry: Prof. J. H. van 't Hoff, translated by Prof. R. A. Lehfeldt, Part 1 (Arnold).—Year-Book of the Royal Society, 1899 (Harrison).—Proceedings of the London Mathematical Society, Vol. xxix., 2 parts (Hodgson).—The Great Salt Lake Trail: Colonels Inman and Cody (Macmillan).—Volcanoes, their Structure and Significance: Prof. T. G. Bonney (Murray).—The Penycuik Experiments: Prof J. C. Ewart (Black).—*Electrician* Electrical Trades Directory, 1899 (*Electrician* Company).—The Story of the British Race: J. Munro (Newnes).—Researches into the Origin of the Primitive Constellations of the Greeks, Phoenicians, and Babylonians: J. Brown, jun., Vol. 1 (Williams).—Under the African Sun: Dr. W. J. Ansorge (Heinemann).

PAMPHLETS.—Regeneration und Entwicklung: Dr. H. Strasser (Jena, Fischer).—Die Lehre vom Organismus und ihre Beziehung zur Sozialwissenschaft: O. Hertwig (Jena, Fischer).

SERIALS—American Journal of Science, February (New Haven).—Astophysical Journal, January (Chicago).—Zoologist, February (West).—American Naturalist, February (Boston).—Botanische Jahrbücher, &c., Sech^r Band, 3 and 4 Heft (Leipzig).—Plantæ Europææ: Richter and Gürke, Tomus ii. Fasc. 2 (Leipzig).—Physical Review, January (Macmillan).—Journal of the Franklin Institute, February (Philadelphia).—Engineering Magazine, February (222 Strand).—Annales de l'Observatoire Météorologique, &c., du Mont Blanc, Tome 3 (Paris).—Brain, Part 84 (Macmillan).—National Geographic Magazine, January (Washington).—Le Monde Moderne, February (Paris).—Popular Astronomy, February. Northfield, Minn.).—Memoirs of the Geological Survey of India, Ser. xv. Vol. 1, Part 3 (Calcutta).—Chambers's Journal, March (Chambers).—Journal of the Chemical Society, February (Gurney).—Good Words, March (Isbister).—Sunday Magazine, March (Isbister).—Century Magazine, March (Macmillan).—Journal of the Royal Microscopical Society, February (London).—Photogram, March (Dawbarn).

CONTENTS.

THURSDAY, MARCH 9, 1899.

CHEMICAL PHYSICS.

Graham-Otto's Ausführliches Lehrbuch der Chemie. Dritte, Gänzlich umgearbeitete Auflage. Erster Band. Dritte Abtheilung. Beziehungen zwischen physikalischen Eigenschaften und chemischer Zusammensetzung der Körper, herausgegeben von Dr. H. Landolt. Pp. 890 (Braunschweig: Vieweg und Sohn, 1898.

THIS work, which has grown out of the comparatively small book on Chemical Physics by Dr. W. A. Miller, first published in 1855, is now complete. Part I., entitled "Physikalische Lehren," was edited by Prof. Winkelmann, with the concurrence of Prof. Kopp, from the previous edition, and was published in 1885. Part II., on "Theoretical Chemistry and Thermo-chemistry," was written by Prof. Horstmann, and was published also in 1885. Part III., which is now complete, is divided into nine chapters, of which the first three were published in 1893, and are now printed without alteration.

The editor has secured the assistance of others, eminent in different branches of chemical physics, to write the various sections of the work; in this way the best information has been obtained, for the subjects are all so rapidly increasing in importance, and so many investigators are engaged on them, that it is practically impossible for one author to produce complete treatises on the several matters with which the book deals.

The first chapter is on the relation between crystalline form and chemical composition, and consists of 350 pages. This commences with an introduction showing the use of crystalline forms for distinguishing substances from one another, and the employment of crystallisation for the purification of bodies, followed by an account of the geometrical properties of crystals, the forms of which are well described, although the student might have been assisted by some diagrams; these, however, may be considered unnecessary, as the crystal forms are fully illustrated in Part I. of this volume. The physical properties of the different systems are given in the form of a table showing the elasticity and cohesion, the optical, thermal, electrical and magnetic behaviour. The first subject dealt with in the chapter is Polymorphism, twelve pages being devoted to its history and discovery; then follows a useful table, occupying twenty-three pages, of polymorphous substances, references being given in every case to the original papers from which the information is obtained: in fact, throughout the book copious references to original papers are given in the form of foot-notes, and in some chapters the year of the publication as well as the number of the volume of the periodical is stated; so that the gradual development of the subjects may be easily traced. It is to be regretted that this is not always done, for the date may be even of more importance than the number of the volume of the journal. The section on Isomorphism, consisting of 141 pages, includes an historical sketch of the subject, the employment of isomorphism for the determination of atomic weights, isomorphous series of elements, of which ten groups are given, the molecular volumes of isomorphous bodies and their geometrical and physical relations and isomorphous mixtures. The third section is on morphotropy or the change that crystalline forms undergo when certain constituents of compounds are replaced by others: seventy-eight pages are devoted to this subject. This is followed by twenty pages of review and explanations of the whole subject, and by thirty pages of additions. In the preface the editor tells us that this chapter was written by Prof. Arzruni in 1892, and it was published in 1893, together with the two following chapters, as before mentioned.

The second chapter (consisting of 111 pages) on the relations between the volumes of solid and liquid bodies and their chemical composition, was written by Prof. A. Horstmann about 1890. The relations of the volumes of gases and of vapours were considered in the second part of this book, so the present chapter deals only with the volume relations of solids and liquids. The atomic volumes of the elements are first considered, and the periodic character of these numbers with increase of atomic weight is pointed out, the molecular volumes of the oxides are shown to be very irregular, although certain resemblances can be traced in oxides of analogous composition, whilst in many isomorphous compounds the molecular volumes are not very different. The molecular volumes of salts containing water of crystallisation are discussed, and it is pointed out that all these numbers will be affected by the temperature at which the specific gravities are determined, so that it is not to be expected that a regularity such as obtains in the case of gases will be found. The molecular volumes of isomeric organic liquids are next compared, and there is a table showing the molecular volumes at 0° and at the boiling points, attention being drawn to the variations under these circumstances. Comparisons are made between the volumes of the halogen substitution compounds of ethane, of isomeric alcohols and ethers and of the isomeric esters of the fatty acids, and lastly the changes of volumes which occur during the formation of compounds organic and inorganic.

The third chapter of thirty-three pages, by Prof. R. Přibram, on the relation between internal friction and the chemical composition of liquid substances, was written in 1892, and was included in the previous publication. After an historical survey of the methods employed for determining the internal friction or viscosity of liquids, it is shown in a table that the viscosity of solutions of salts increases with the basicity of the acid, the acids are compared with the corresponding salts of ammonium, potassium and sodium, and the viscosity of the sodium salts is in all cases the highest. The next comparison is between the viscosity of salt solutions and their electric conductivity: as a rule there is a diminution of conductivity for an increase of viscosity; and a list is given of the viscosities of organic acids and their sodium salts and of solutions of chlorides, sulphates and nitrates of several metals. The chapter concludes with a table showing the viscosity constants of a number of organic liquids, with remarks on the relations existing between them and the composition of the componnds. The work of Thorpe and Rodger is of more recent date than this chapter, but some reference might have been made to it in the reprint.

The next chapter is by Dr. Willy Marckwald, on the

relation between melting points and the composition of chemical compounds. It occupies twenty-seven pages, and was begun in 1897. For an account of the periodic character of the melting points of the elements, reference is made to the second volume of the book, the fusing points of compounds only being dealt with in this chapter. A few examples of the fusing points of inorganic compounds are given, showing that those of the chlorides, bromides and iodides of the elements of a period fall with the increase of atomic weight; the period chosen being the second in the periodic table beginning with sodium, and ending with chlorine. When the haloid compounds of a group are examined, it is found that, generally speaking, the fusing points rise with an increase of atomic weight; this is exemplified by the compounds of the beryllium and nitrogen groups, but the haloids of the alkali metals behave irregularly. Tables iv. and v. give the melting points of isomeric organic compounds, in which it is seen that the symmetrical compounds melt at higher temperatures than the unsymmetrical. In the next table the fusing points of the para- meta- and ortho-compounds of benzene are compared, and it is shown that the para-compounds always fuse at the highest temperatures, whilst in the case of the sulphamides the ortho-compounds have the highest fusing points. More complex compounds are then studied, and the chapter contains no less than thirty-nine tables, in which the melting points of allied chemical compounds are compared.

The fifth chapter is also by Dr. Willy Marckwald, on the relation between the boiling points and the composition of chemical compounds. This was begun in 1897, and extends over twenty-nine pages. The chapter deals with organic compounds only, and contains forty-one tables giving the boiling points of bodies of various series. In some of the tables boiling points under varying pressures both above and below that of the atmosphere are included.

Chapter vi., on the relation between refraction and the chemical composition of bodies, was written in 1897 by Dr. E. Rimbach, and consists of ninety-seven pages, the first twenty-three of which are devoted to generalities in which the different methods of determining refractive indices are briefly mentioned and the three formulæ for calculating the specific refractive powers of bodies proposed by Laplace, by Dale and Gladstone, and by Lorenz and Lorentz are discussed, comparison being made of the constancy of the numbers obtained by the use of the different formulæ under varying conditions. The following section is on molecular refraction and the constitution of bodies; isomeric liquids are first considered, and it is shown that the differences of refractions of such bodies are not great unless there is a pronounced difference in their chemical structure; thus those bodies in which double bonds are supposed to exist, have different refractive powers from those in which single bonds occur; and it is seen that in homologous series the difference of CH_2 makes a nearly constant difference in the molecular refraction of the substance, and by subtraction the value of CH_2 is obtained. Similarly the values of carbon, hydrogen and oxygen are calculated, the latter element showing different numbers according to the other elements with which it is combined in the molecule. The atomic refraction of the constituents of a compound when added together should give the molecular refraction of the compound, but in cases in which the carbon atoms are doubly or trebly linked a difference is always found, and from these differences the values of multiple bonds are obtained. Cyclic compounds are next considered, and the effect of the three double bonds in the benzene ring is shown by the comparison between the observed and calculated molecular refractions of a number of benzene derivatives. The atomic refraction of the halogens is then studied, followed by some observations on molecular dispersion. The next section is on compounds containing nitrogen, and here it is seen that the atomic refraction of nitrogen varies according to the way in which it is combined in the various substances. The atomic refraction of other elements such as sulphur, phosphorus, arsenic, antimony, silicon, mercury, tin and lead are next dealt with. There is a short section on the refractive powers of gaseous bodies, and another on those of solids and of their solutions. The concluding section treats of electrical molecular refraction and the relation between dielectric constants and the constitution of bodies.

The next chapter, on the relations between the chemical nature and the spectra of elementary and compound bodies, was written in 1889 by Prof. Gerhard Krüss, and after his death in 1895, his brother, Dr. Hugo Krüss, wrote some additions. The chapter consists of twenty-five pages, and the addenda of seven. Emission spectra are first considered, and the relations between the wave-lengths of the lines in the spectra of various elements are shown to be the same as those between the overtones of a fundamental note, tables being given comparing the observed and calculated wave-lengths of the spectral lines of certain elements; the characteristics of the spectra of the elements of various groups are described, and also the relation between the spectra of compounds and those of their constituents. Absorption spectra of inorganic compounds are briefly mentioned, whilst those of organic compounds are fully treated and the alterations of the spectra by the introduction of different radicals are noticed. In the additions made by Dr. H. Krüss the remarkable investigations of Kayser and Runge on the several series of lines in the emission spectrum of an element are dealt with, and the connection between these observations and the periodic law are shown. There is also a short discussion on the variation of absorption spectra of solutions in connection with the ionic hypothesis. We do not find any notice of Abney's researches on the absorption in the infra-red part of the spectrum by organic bodies.

The eighth chapter, of eighty-four pages, deals with the relation between the optical rotation of organic substances and their chemical composition, and was written by the editor, Dr. H. Landolt, and finished in 1898. For methods of measuring circular polarisation reference is made to Part I. The rotation of the plane of polarisation by crystals is briefly mentioned, and a list is given showing the rotation for plates 1 m.m. in thickness and also the systems to which the crystals belong. The rotation by liquids follows, a list of thirty groups of active substances being given, and the method of finding the specific molecular rotation is described. The specific rotation of dissolved substances and the changes which

are observed in solutions of different concentration are discussed at length. The second section is on the connection between the optical rotation and the chemical constitution of carbon compounds, in which the original observations of Pasteur and the theory of the asymmetric carbon atom of Van 't Hoff and Le Bel are fully described, a subject on which a vast amount of work has been recently done. The third section is on the relation between the magnitude of the rotation and chemical constitution, and accounts are given of the rotations of isomeric bodies, of bodies belonging to homologous series and the effect of multiple bonding of carbon atoms.

The last chapter of the book is by Dr. O. Schönrock, on the relation between the electromagnetic rotation of solid and liquid bodies and their chemical composition; it extends over seventy-three pages, and was finished in 1898. The observation made by Faraday in 1846, that the plane of polarisation is rotated when the beam is passed through a transparent substance placed in a powerful magnetic field has led to valuable researches, principally by Perkin, on the rotation produced by various chemical compounds. The mode of calculating the molecular magnetic rotation and the influence of solvents are first mentioned, and then the effects produced by inorganic acids and salts and the atomic rotation of the elements. The periodic character of the magnetic rotation of some of the metals is pointed out. The next part deals with fatty substances, and numerous tables are given showing the variations which occur with change of composition, and the influence of the various radicals is calculated.

The volume concludes with an index of twenty-three pages, divided into sections corresponding to the nine chapters of the book; by this means the physical characteristics of the chemical substances can at once be found.

The whole volume has evidently been compiled with great care, and brings together a large amount of valuable information distributed in the *Transactions* of societies and other periodicals, thus saving the investigator desiring to make use of these researches, a great deal of time and labour in referring to the original papers. It will also enable the chemist to appreciate the great assistance that he may obtain from the study of the physical properties of compounds in his endeavours to ascertain their constitution and their relation to one another. H. M.

THE SCIENTIFIC STUDY OF VACCINATION.

Vaccination: its Natural History and Pathology. By Dr. S. M. Copeman. Pp. x + 257. (London: Macmillan and Co., Ltd., 1899.)

THE Milroy Lectures on the Natural History and Pathology of Vaccination, delivered last year before the Royal College of Physicians, are now at an opportune moment given to the public. The Vaccination Act of 1898 has practically abolished compulsory vaccination. On the other hand, it aims at improving the administration of vaccination and at removing all objections that can, with the least show of reason, be brought against it. Without in any way admitting the existence of adequate grounds for giving up compulsory vaccination, which we look upon as a grave national misfortune, it must be acknowledged that opposition to the compulsory law has been in a measure based upon administrative defects. To do away with that opposition the first thing wanted is much greater care in the methods employed. Illness and death from vaccination ought to be as rare here as in Germany. To attain this end two things mainly are wanted: a scientific study of the quality of the lymph used, and a rigid and minute adherence to antiseptic principles on the part of the vaccinator. A lymph which is pure, in a bacteriological sense, and aseptic conditions from first to last, as regards the wounds made, ought to do away with all vacccination accidents.

Dr. Copeman's book deals mainly with the first of these subjects. In the early chapters he reviews the history of vaccination, of various lymph stocks, and of the relationship between variola and vaccinia. He relates the experiments made from 1801 to the present time, to prove experimentally the truth of Jenner's original thesis that vaccinia is small-pox of the cow. The experiments detailed are those of Gassner (1801), Viborg (1807), Thiele (1836 and 1838), Ceely (1839), Badcock (1840), Adams and Putnam (1852), Simpson (1885 and 1892), Fischer (1886 and 1890), King (1889), Hime (1892), Haccius and Eternod (1893), and Klein (1892). All these observers succeeded in inoculating human small-pox into a cow or calf, and in developing cow-pox as the result. Dr. Copeman's own experiments date from 1892. He was successful in one out of four attempts. The transformation of small-pox into cow-pox seemed in most of the successful experiments to require a series of inoculations from one cow or calf to another, and not to be an immediate result on first inoculating the contagium into its new conditions. It was probably from not knowing this fact that Chauveau, in 1865, and Martin, of Boston, in 1860, reproduced human small-pox by vaccinating from cows who had been the subjects of variolous inoculation. The variolous poison had, in these cases, not had the time required for its transformation into vaccinia. There remains, however, much still to learn as to the conditions under which the change from variola to vaccinia is accomplished.

With regard to the bacteriology of vaccine lymph, a subject on which much laborious investigation has been expended, Dr. Copeman comes to the conclusion that from lymph taken from matured vesicles "inoculation of plates or tubes of nutrient material usually result in abundant growths of micro-organisms." Dr. Copeman succeeded, however, in growing the small-pox contagion as a pure culture, by using hen's eggs as the culture medium. "For the purpose of such inoculations I employed variolous crusts. . . . These crusts were rubbed up in a small glass mortar with a minimal quantity of water . . . and the inoculation was carried out. Finally the small hole in the egg was closed up." The eggs so inoculated were kept in the incubator for a month, and calves were then inoculated with the egg culture, and after being passed through a series of calves the resulting lymph was successfully used for the vaccination of children. Drs. Copeman and Blaxall have since obtained pure cultures of "the same organism on the surface of agar plates, and this not only when vaccine

lymph, both of human and bovine origin, was employed, but from variolous lymph as well." From these plates sub-cultures were obtained, and from the third and fourth generation typical vaccinia was induced both in calves and in children.

Monkeys have been of considerable assistance to Dr. Copeman in his investigations upon lymph. He began by proving experimentally that they are susceptible both to vaccination and to variolation, and he found that in them vaccinia protected from small-pox, and *vice versa.* "In no instance had the experiment a fatal termination," nor does it appear from the report that even variolation caused serious illness; it was "inoculated" rather than "natural" small-pox. Dr. Copeman adds:

"In discussing the origin of the various lymph stocks at present in use, Messrs. Collins and Picton in their minority report make a point of the impossibility of employing at the present day what used to be known as the 'variolous test' as a proof of the efficacy or the reverse of any particular strain of lymph. In view, however, of my experiments with monkeys this criticism . . . falls to the ground; since if it is desired to apply the variolous test to any given lymph stock, all that is necessary is to vaccinate a monkey with a sample of the lymph in question, and subsequently to inoculate the animal with potent small-pox lymph after the lapse of such period from the first operation as may be thought desirable."

Dr. Copeman's researches upon the effect of glycerine in purifying and preserving vaccine lymph, date from 1891. Previous to this he had seen reason to think that the exuberant growth of what may be called extraneous organisms, might tend to check the development of the more important organism for which he was searching. He therefore set himself to find an agent which would check the growth of these extraneous or useless micro-organisms in lymph.

The use of glycerine as a diluent or preservative of lymph had long been known. What was not known was that by an intimate admixture of perfectly pure glycerine with lymph, and by storing the mixture for a considerable time under conditions which prevent the access of air and light, the foreign organisms in the lymph are gradually destroyed or so checked in their growth that they cease to multiply and come to an end. The proportion of glycerine required for this inhibitory influence is a large one—30 per cent., 40 per cent., or 50 per cent. for the different organisms. Dr. Copeman details experiments made by himself and Dr. Blaxall with lymph to which had been added, a month before using it, large quantities of virulent tubercle bacilli. No growth of the tubercle bacillus could be obtained, nor was any effect produced by repeated injections of this lymph into guinea-pigs, while from the same supply of tubercle culture material, not treated with glycerine, tuberculosis was in due course developed, at first locally and then generalised.

It must be borne in mind that an essential part of the process Dr. Copeman recommends is the length of time during which the organisms in the lymph are exposed to the influence of chemically pure glycerine, unaided by the vitalising influences of light and air.

Dr. Copeman gives photographs of a series of sub-cultures on nutrient agar-agar after twenty-four hours, then after one, two, three, four and six weeks respectively. The extraneous organisms progressively diminished till at the end of four weeks there were none, and after six weeks there were also none.

It is natural to ask if glycerine can in time, and under favouring conditions, entirely inhibit the growth of extraneous organisms, will not the essential vaccine organism presently share the same fate? Is glycerinated calf lymph sure to retain its activity for a sufficient length of time for all practical purposes? These questions scarcely admit at present of an absolute answer. Dr. Copeman believes the lymph from different calves varies very much in potency. He quotes facts which go to show that there is no reason to distrust the lymph treated as he recommends while stored in bulk.

"A lymph which was collected and glycerinated on July 13, 1897, has since been used at intervals of from twenty-four to thirty-two weeks after glycerination, for the vaccination of children. During this period sixty-one children have been vaccinated with this lymph in five places each, with a mean insertion success of 98 per cent."

It must, however, be borne in mind that for the children thus vaccinated the lymph had not been kept in capillary tubes. It is necessary to wait for further experience before it can be taken as proved that glycerinated lymph can be kept in an active condition for any considerable time in such tubes. It would be interesting to know if lymph can be stored and distributed in fairly large bulk in such a way as to be available when wanted, even where, as on board ship, otherwise perfect conditions as to temperature, exclusion of light and air can be secured. A method by which enough perfectly pure lymph to vaccinate, say, a thousand people, in one series, could be carried through the tropics would be of great value, and there seems some ground for doubting if glycerinated calf lymph in capillary tubes would under such conditions be absolutely trustworthy. It would have for the round voyage to retain its potency for at least from four to six months.

Dr. Copeman's contribution to the study of the bacteriology of vaccination is of high value and interest.

A MODERN TYCHO.

Siddhánta-Darpana; a Treatise on Astronomy. By Mahámahopádhyáya Sámanta Sri Chandrasékhara Simha. Edited with an introduction by Jogés Chandra Ráy, M.A., Professor of Physical Science, Cuttack College, Calcutta, 1897.

ANY one who reads the very interesting introduction of sixty-one pages that Prof. Ráy has attached to this Sanscrit work will regret very much his inability to fathom the work that follows. For therein is contained the results of the patient and industrious inquiry of one who, unaided by the accumulated knowledge of Western astronomers, resolutely set himself to solve the problem of celestial mechanics by the aid of such instruments as he could fashion himself, and where the time-honoured clepsydra supplied the place of the sidereal clock. The only assistance he seems to have had were the similar rough observations of Bháskara (born 1114) and some still older observers. Prof. Ráy compares the author very

properly to Tycho. But we should imagine him to be a greater than Tycho, for without the same assistance, without the encouragement of kings and the applause of his fellows, he has advanced his favourite science quite as effectually as did the Danish astronomer. It is especially curious to notice that the system at which Chandrasékhara ultimately arrived, and the explanation he offers of it, bears a very considerable resemblance to that which Tycho taught. The author has never been able to convince himself that the earth turns on its axis, or that it goes round the sun; but to the planets he assigned heliocentric motion, much as Tycho did.

We get some notion of the success that attended the work, and of how much it is in one man's power to accomplish, if we examine the differences between the values he assigns to some of the constants of astronomy and those in use with ourselves. The error in the sidereal period of the sun is 206 seconds; of the moon, 1 second; Mercury, 79 seconds; Venus, about 2 minutes; Mars, 9 minutes; Jupiter, an hour; and Saturn, rather more than half a day. The accuracy with which he determined the inclination of the planets to the ecliptic is still more remarkable. Mercury offers the largest error, and that is only about two minutes. In the case of the Solar orbit the greatest equation to the centre is only 14 seconds in error. In the Lunar theory, the revolution of the node has been concluded with an error of about $5\frac{1}{2}$ days, less than the thousandth part of the whole period; while he has independently detected and assigned very approximate values to the evection, the variation, and the annual equation.

The main object that Chandrasékhara had before him seems to have been to correct the calendar, and regulate the daily ritual of the Hindu religion. No two almanacs, Prof. Ráy tells us, agree; but any attempt to introduce the Nautical Almanac and its acknowledged accuracy would prove unsuccessful. The necessary corrections and unification must, to be acceptable, come from within and be the work of a Hindu, uninfluenced by foreign education. The work of Chandrasékhara has received the sanction of the honoured Rashis, and the adoption of the corrections which he has shown to be necessary will exert upon native society a beneficial influence, whose importance can be hardly overrated in a community where a correct almanac is an indispensable equipment of every household. We should like much to linger over Prof. Ráy's remarks on the subject of precession and his chronological deductions. These and many other points are discussed with great ability, though Prof. Ráy modestly disclaims any special astronomical capacity. The effect is to leave us at every page with a higher opinion of the author laboriously recording his observations on a palm-leaf, and unselfishly devoting his life to the services of his countrymen, who do not appreciate the nobility of the effort and the entirety of his devotion. We are in full sympathy with the editor when he writes thus of the author, of his privations and his star-gazing:

"What has he done after all? asks the impatient critic. To him I would say—Is it not enough to find in this man a true lover of science, who, regardless of other people's unfavourable opinion of his work, their taunts and dissuasions, has devoted his whole life to the one pursuit of knowledge; who has shown the way to original research amidst difficulties serious enough to dishearten men in better circumstances; who has employed his time usefully, instead of frittering it away like the usual run of men of his rank, on a work which guides the daily routine of millions of his countrymen."

W. E. P.

OUR BOOK SHELF.

Photography: its History, Processes, Apparatus, and Materials. By A. Brothers, F.R.A.S. Second Edition. Pp. xviii + 367. (London: C. Griffin and Co., Ltd., 1899.)

MR. BROTHERS, of Manchester, has been known for so many years in connection with photography and allied subjects, that his personal experiences have much value for the student. The time is gradually approaching when the history of the early developments of photography will be completed, because it will be impossible to add to our recorded knowledge of them; meanwhile we welcome every addition. Mr. Brothers describes the first experiments in the use of magnesium as an illuminant for photographic purposes, and how he found that the wire burned better when it was flattened into ribbon by passing it between rollers. The first photograph taken underground was by Mr. Brothers, and he gives a reproduction of it. It was produced in 1864 in the Blue John Mine in Derbyshire, by the aid of burning magnesium. In the following year Prof. Piazzi Smyth used the same illuminant in photographing the chamber in the interior of the Great Pyramid. Being in doubt as to who was the first to use sodium thiosulphate as a fixing reagent, Mr. Brothers, in 1866, wrote to Sir John Herschel, and received from him a long letter on the subject, which is printed in full in the work before us. In it Sir John gives quotations from his papers on "hyposulphurous acid and its compounds," published in the *Edinburgh Philosophical Journal* of 1819, and also extracts from his own laboratory note-book of January 1839, which appear to establish his claim to being the first to use the thiosulphates in photography. The description of Sir John's attempts to imitate the photographic successes of Daguerre, of which at that time there were only very vague reports as the process was not published until later in the year, are very interesting.

Although the volume is called a "Manual of Photography," it is hardly what is commonly understood by this term. After introductory matter, which is chiefly a consideration of chemistry, optics, and artificial light, as applied in photography, there follow sections titled "Processes," "Apparatus," "Materials used in photography," "Applications of photography," and "Practical hints." In each section the numerous headings are alphabetically arranged, their descriptions extending from two or three lines to, occasionally, several pages in length. The space allotted to each subject is not proportional to its demands. While more than eight pages are devoted to the stereoscope, less than three are given to carbon printing, and for details of this most important of processes the student is referred to the guide issued by the Autotype Company! This being a second edition, much new matter has been added, Radiography, the "krōmoscōpe," the new developers, and some of the newer lenses are described, the last chiefly by quotations from the makers' price lists. The greatest advance in photographic optics since Petzval calculated the portrait lens that bears his name, is practically ignored. Astigmatism is referred to, in a dozen lines or so, as "a defect most general in portrait lenses" that "has to be reduced to a minimum by the use of a diaphragm." It is worth noting that at both pages

where given, the formulæ of the very soluble and of the sparingly soluble double thiosulphates of silver and sodium should change places. The volume is enriched by many beautiful specimens of photographic methods of illustration.

Wonders of the Bird World. By R. Bowdler Sharpe. Pp. xvi + 399. Illustrated. (London: Wells Gardner, Darton, and Co., 1898.)

Mr. Sharpe's lectures on the "Curiosities of Bird Life" obtained such extensive and well-merited popularity, that their reproduction, with extensive additions, in book-form may be welcomed; more especially since, owing to ill-health, the author has been compelled to abandon the lectures themselves. Although apparently not containing much new matter, the volume is certainly a most interesting production, calculated to attract readers who possess little or no claim to rank as naturalists. It teems with anecdote; and, for the most part, is singularly free from dry technicalities.

It is true that in one chapter we have the inevitable list of "orders and families" of birds, but elsewhere classification is conspicuous by its absence; and the chief aim of the author seems to be to treat his favourites from the aspect of habits. We have, for instance, chapters on coloration, nesting and nests, courtship and dancing, mimicry and protective resemblances, and parasitism. The volume commences with two chapters on "wonderful birds," in which the reader is introduced in a popular way to some of the most remarkable extinct types. Among these, reference may be made to some excellent restorations from the pencil of Mr. W. P. Pycraft, which seem to convey the best possible idea of what these birds looked like in life. And here attention may be directed to the beauty of the illustrations generally, most of which are by Mr. A. T. Elwes. If it be not almost invidious to make a selection, the figures of the secretary-bird and white-headed stork strike us as especially deserving of commendation. While mentioning that every bird is really "wonderful," Mr. Sharpe includes in his first two chapters all the ratite birds, the hoatzin, the megapodes, dodo, and penguins; all of which are rightly placed in this assemblage.

To analyse the book is entirely beyond the limits of our space, but we may specially draw attention to the chapters on nesting habits; and among these to the very interesting account of the entombment and feeding of the female hornbill during the period of incubation. The notes on the cuckoos, and especially the resemblance of the black cuckoo to the drongo, also strike us as being of more than ordinary interest. But when all is so good we must refer the reader to the work itself.

The weakest chapter in the book is undoubtedly that dealing with the geographical distribution of birds; and in this, we venture to think, the author has by no means availed himself of all the information accessible. Indeed, we may say he is distinctly behind the time; especially as regards the relations of the Malagasy fauna to that of Africa. And here we must protest against the bugbear "priority" being made an excuse for employing the discredited term "Lemurian" instead of Mascarene.

We could wish, also, that the author would make up his mind as to the names to be employed for particular species of birds, instead of constantly changing them. For instance, we find in his "Handbook of British Birds," published a few years ago, the swift figuring as *Micropus apus*, whereas it appears here (p. 226) as *Apus apus*. Again, in the former work we have Capercailzie, in the present one (p. 352) Capercailie. If *Apus* is entitled to stand for the bird, it must be discarded for the well-known crustacean. Misprints are few, although we notice (p. 254) *Eurypya nelias* standing in place of *Eurypyga helias*. R. L.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Chemists and Chemical Industries.

The two letters on this subject in your issue of February 23, the one by my good friend Mr. Friswell, the other by my distinguished pupil Mr. Pope, are in striking contrast: the former says much that is true, but in the end, I think, gives an entirely false impression.

Why things here and in Germany are different has little in anything to do with the technical teaching given in the two countries: the German teachers are as much "academical chemical pedagogues" as are we English—perhaps a little more so. Manufacturers—firms like Mr. Friswell's—are mainly responsible for our decadence. Next to Perkin, his original firm were pioneers in the aniline colour industry; how many *trained chemists* have they had in their employ? Half a dozen? How many have been engaged in the industry in the country generally? A score? And in Germany hundreds! Germany owes her success to the fact that her manufacturers and merchants are cute men of business, willing to give themselves infinite trouble, and who not only understand their business but also appreciate the value of science. Ours as a class do not know what science is—does, for example, a single one of Mr. Friswell's directors really know what aniline is?

Mr. Friswell by implication libels our English schools when he says: "Our technologists must come from Germany, or go there to be made." Prof. James Stuart, in the otherwise most admirable rectorial address he recently delivered at St. Andrews, made a similar erroneous statement. It is time that this aged German ghost were laid and such utterly false doctrine put aside. Faults our schools have, and grave ones, but they have made an extraordinary advance of late years and are daily becoming more practical and less academic—and this notwithstanding that our universities regard research work only as a post-graduate exercise and by teaching reliance on authority do their best to kill the goose that is to lay the golden eggs, a policy the very reverse of that pursued in Germany; and notwithstanding also that we expatriate our most capable students by Royal Commission and sustain them abroad practically as assistants—and very competent ones, too—of foreign workers, much to the detriment of our own schools and very often little to the advantage of the student. We now give in quite a number of our schools an education even superior to that given in Germany, and our native product is to be found doing the best of work throughout the country. I will go further and say that in too many German schools much that is now taught and learnt is certainly not science and most harmful, exact and painstaking work having given place to wild speculation. It is partly because this is felt to be the case that the movement discussed in Dr. Fischer's pamphlet has been initiated. I yield to no one in respect and admiration of German achievements, but we carry adoration too far and in our gratitude for the many services German teachers have rendered us forget that neither is England Germany nor the English character identical with the German—*Gott sei Dank*—both nations having peculiarities of which each is justly proud.

If English manufacturers will show their appreciation of science as the Germans do by giving employment *at fair wage* to men who have learnt to think for themselves as well as to work honestly and exactly, our schools will soon be filled to overflowing—genius will be attracted to them, and the tide of German competition will be easily stemmed in so far as chemists can stem it. But a far darker cloud looms in the near distance, which probably will overshadow both Germany and us: for it is very doubtful if we shall succeed in holding our own against American readiness, resourcefulness and organising ability; this, indeed, is a factor in the coming struggle which we shortsighted English seem altogether to miss out from our calculations, but it were well that we noted it seriously.

Henry E. Armstrong.

Wehnelt's Contact-Breaker for Induction Coils.

This important advance in technique will undoubtedly lead to increased activity in X-ray work, and I trust the following notes will therefore be of interest to your readers.

No one can doubt the great advantages of Dr. Wehnelt's instrument in reducing the time of exposure of photographic plates, the brilliancy and steadiness in the fluorescent screen, not to mention its cheapness. The question of disadvantages having been raised, such as control of the instrument, destruction of tubes, &c., I made a few experiments to see how far such would affect its utility. My experiments were made with induction coils of different sizes, the largest being a 28-inch spark, and in each case the principles involved seemed to be the same. Firstly, we can vary the effects in the tube by increasing or diminishing the voltage to the primary coil. Secondly, the current is easily controlled by difference in proportion of the size of the electrodes. Thirdly, the strength of the fluid in which the electrodes are immersed affects the result. Fourthly, by the distance between the electrodes in the electrolyte changes are brought about. Fifthly, variations are got by the number of active electrodes. By modifying these we can vary the length of the spark, also its frequency and thickness, and it naturally follows that we can make use of them in exciting Crookes' tubes. In fact, so easy is it to arrange matters that I have been able to excite small and large tubes of different vacua with perfect safety even when using a large 28″ spark coil. So far, therefore, from being afraid of its destructive power upon the antikathode or Crookes' tubes generally, I am convinced that the new interruptor will be very easily controlled. I may add that some workers are inclined to think that large coils will no longer be required, but the answer depends entirely upon the work to be done. What we already do know, and what is of greater importance, is that coils of any size can do what was beyond their range in the past—a fact of great value where portability is of consequence, as in hospital work or to the army-surgeon on the field.

So far I have therefore been quite able to confirm everything promised by Dr. Wehnelt. Photographs taken by me of the deep-seated tissues of the body have been obtained with very much shorter exposures than by any other means of interruption. Further, examination of these deep-seated structures has been made much easier by the greater brilliancy and steadiness of the fluorescent screen.

Another question sure to be raised once more by this new instrument is which is the best instrument for X-ray work judged by the comparative advantages and disadvantages of induction coils and influence machines. Hitherto one of the great advantages of the latter has been the brilliancy and steadiness of the illumination of the screen, but this difference may be said to have disappeared with the advent of Dr. Wehnelt's discovery. When the question of the best transformer was discussed at the Röntgen Society last session, I could not see my way to take any side, believing then, as I do still, that each transformer has its advantages and disadvantages. It would possibly be as easy to say whether a gas, oil, or steam engine should be chosen to do a particular piece of work. At that meeting I stated that when we come better to understand coils and influence machines, we shall probably do the same work with either. The selection of the instrument to excite Crookes' tubes in the future will probably be decided by such questions as portability, the primary force at the disposal of the operators, such as batteries, street mains, or mechanical power.

179 Bath Street, Glasgow, JOHN MACINTYRE.
March 5.

To Calculate a Table of Logarithms.

ON the 23rd ult. you were good enough to publish for me a short account of a method of calculating a table of logarithms which any schoolboy might employ. I find that this method is described in a book published a few days ago, "Measurement and Weighing," by Edwin Edser, an associate of this college. The method was used by Mr. Edser in teaching students of the Chelsea Polytechnic. To find that young teachers are working in the spirit evidenced by such an exercise, gives me many times more pleasure than any that I could derive from credit for priority. JOHN PERRY.

oyal College of Science, South Kensington, S.W.,
March 1.

Probable Weather Conditions in Spain during the Total Solar Eclipse of May 28, 1900.

THINKING that some information about the climatological conditions of the Spanish towns situated in the track of the shadow during the total solar eclipse of May 28, 1900, may be welcomed by the readers of NATURE, I have collected the few available observations made at meteorological stations situated near the path. Only two are in the limits of the central shadow: inland, Albacete; and Alicante, on the sea-shore.

Weather Chances towards the End of May, deduced from several Years of Observation.

Towns	Barometer	Temperatures Max.	Min.	Mean	Wind Direction	Velocity	Days of Clear	Cloudy	Overcast	Rain	Fog	Rain mm.	Humidity per cent.
Albacete	702·5	21·0°	9·3°	15·9°	S.E.	5	9	15	9	8	0	49	66
Alicante	759·4	25·3	11·4	18·9	S.E.	5	15	14	3	4	0	28	76
Caceres	719·2	22·8	10·0	16·4	S.W.	4	8	19	4	11	0	114	62
C. Real	707·2	23·7	8·5	14·9	W.	4	10	11	10	9	0	50	62
Murcia	756·6	25·1	12·5	19·0	S.E.	5	8	18	5	5	1	30	58

The Spanish astronomer, Mr. Landerer, has drawn up the times of contacts for the towns expressed in the following table. (Madrid mean time.)

Localities	External contacts h.	m.	s.	Totality Contacts h.	m.	s.	Duration m.	s.
Oporto	2	3	28	3	27	00	0	55
	4	34	37	3	27	55		
Ovar	2	3	30	3	27	3	1	33
	4	35	9	3	28	36		
Vizeu	2	7	42	3	30	58	1	31
	4	38	28	3	32	29		
Plasencia ...	2	18	48	3	41	14	1	29
	4	47	36	3	42	43		
Navalmoral ...	2	21	44	3	44	3	1	28
	4	50	20	3	45	31		
Argamasilla ..	2	35	59	3	56	59	1	22
	5	1	58	3	58	21		
Albacete	2	43	31	4	3	38	0	40
	5	7	26	4	4	18		
Tobarra ..	2	45	31	4	4	48	1	20
	5	9	6	4	6	8		
Novelda ...	2	49	40	4	9	24	1	18
	5	13	15	4	10	42		
Elche ...	2	50	18	4	9	59	1	19
	5	13	56	4	11	18		
Alicante ...	2	51	25	4	10	52	1	12
	5	14	43	4	12	4		
Santa Pola ..	2	51	9	4	10	38	1	18
	5	14	29	4	11	56		
Argel	3	11	47	4	29	25	1	9
	5	31	41	4	30	34		

AUGUSTO ARCIMIS.
Instituto Central Meteorologico, Madrid.

A Remedy for Bookworms.

REFERRING to the letter from Mr. J. Ewen Davidson on this subject (NATURE, vol. lix. p. 126). In my experience of keeping books in Fiji and various parts of Australia, I have only had to contend with the attacks of rats, cockroaches, "silverfish" (*Lepisma*), and a small boring beetle; all of which attack the binding, probably for the sake of the starch, paste &c.

The solution of corrosive sublimate, recommended by Mr. Davidson, will undoubtedly prove *permanently* effective without the thymol.

Some objection may, however, be taken to the use for this purpose of a powerful poison like corrosive sublimate.

I have attained the same end by giving the bindings a dressing of strong shellac in spirit. This is easily applied by means of a soft brush, and dries quickly, when it is scarcely noticeable even on fine bindings.

Where large numbers of books have to be cared for, as in libraries, "silverfish" and cockroaches are, in this climate, the enemies perhaps most to be dreaded. These lurk and breed in the spaces between the woodwork and the walls, and in crevices and crannies about the shelves.

Mr. J. J. Fletcher, Secretary to the Linnean Society of N.S.W., has effectually rid the library of the Society of these pests by freely dusting into the crevices ordinary powdered Paris green. Wherever there was a space in which the insects could lurk, Mr. Fletcher applied the powder, and now the books, which were formerly much disfigured by the insects nibbling the bindings, remain entirely free from damage because of the extermination of the pests, THOS. STEEL.

Colonial Sugar Refinery Company, Sydney, January 31.

Radiation in a Magnetic Field.

IN the very interesting summary of our present knowledge of the Zeeman effect, Mr. Preston has interpreted a number of results I obtained by the interferometer and the echelon spectroscope in such a way as to cast a general doubt over the performances of these instruments. Some of these interpretations are undoubtedly the result of misunderstandings due to my own want of clearness. I venture, therefore, to present a summary of the principal results, emphasising where necessary the points which require further explanation.

In the article to which Mr. Preston refers (*Phil. Mag.*, vol. xxxiv. p. 280, 1892), it was shown that the visibility curve, in the case of about twenty radiations examined, showed peculiarities from which the character of the spectrum could be inferred, and a considerable number of "lines" were shown to be double, triple, or more highly complex. Mr. Preston remarks: "This structure has never yet been observed by means of any ordinary form of spectroscope, and accordingly it has been suggested that it does not exist in the light radiated from the source, but is imposed on the spectral lines by the apparatus used, namely, the interferometer."

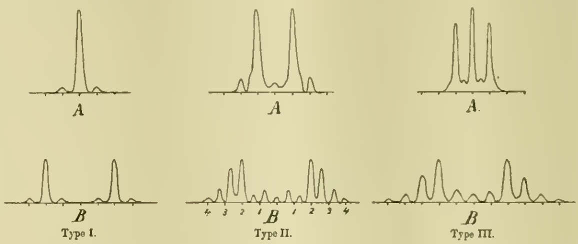


FIG. 1. A, plane of polarisation, Equatorial.
B, ,, ,, Axial.

It might be replied that such an explanation would be very difficult to accept, in view of the very great constancy of the results, with instruments of different construction and dimensions, with different observers, and with different forms of vacuum tubes employed. But, if I am not mistaken, the only attempt at explanation of the peculiarities of my visibility curves, was that which attributes them to diffraction effects; which, however, would necessarily be of a totally different character, and indeed in most cases entirely insignificant.

The real reasons for the absence of confirmation of these results by the spectroscope are probably that the resolving power is insufficient; or where the resolving power is insufficient the radiating substance is not in a vacuum tube, and the consequent broadening of the lines under atmospheric pressure is so great as to mask the details of structure; or, finally, if the substance is placed in a vacuum tube, the light is not sufficiently bright.

Turning now to Mr. Preston's criticism of the results obtained in the investigation of the Zeeman effect, the following remarks may help to clear up the "most surprising statement that the separation of the lines in the triplets produced by the magnetic field is independent of both the spectral line and the substance."

The law referred to is stated thus: "The separation is proportional to the strength of field, and is *approximately* the same for all colours and for all substances."

But on p. 137 of the same article (*Astrophysical Journal*, vol. vii. No. 2, 1898) will be found the further modification:

"The following table shows that the law . . . is only approximately true. In fact, owing to the complexity of the spectra, there is considerable latitude in the choice of the distance between the outer groups. If this correspond to the brightest components *the law can hardly be said to hold at all*; but if the distance be taken between the centres of gravity of the light areas, a fair agreement is found. The table gives separation in tenth-meters for a field 10,000. The lines marked with an asterisk are less accurate than the others on account of broadening:

*Hydrogen	...	Red	...	0·48
*Lithium	...	Red	...	0·60
Cadmium	...	Red	...	0·42
Zinc	...	Red	...	0·42
Mercury	...	Yellow	...	0·36
*Sodium	...	Yellow	...	0·50
*Helium	...	Green	...	0·37
Mercury	...	Green	...	0·40
Cadmium	...	Green	...	0·41
*Thallium	...	Green	...	0·36
Cadmium	...	Blue	...	0·40
Zinc	...	Blue	...	0·33
Mercury	...	Violet	...	0·33

"Taking into account the uncertainty alluded to, the results show on the whole a fair agreement, from which it may be concluded that the separation is independent of the radiating substance and of the colour."

A number of radiations have been examined since the foregoing was published; and while there are undoubted exceptions to the law, I still think, keeping in mind the limitations referred to, it is in the main correct.

These results and others obtained by the interferometer, as Mr. Preston states, have been verified by the echelon spectroscope; and I think the explanation of apparent differences between results obtained by these methods and by other forms of spectroscope are to be explained, not by an actual variance, but by a misunderstanding of the degree of approximation the results

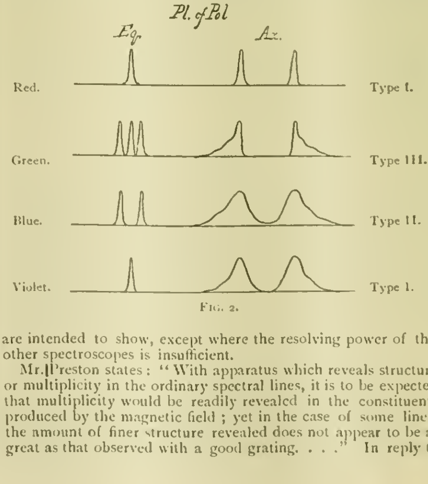


FIG. 2.

are intended to show, except where the resolving power of the other spectroscopes is insufficient.

Mr. Preston states: "With apparatus which reveals structure or multiplicity in the ordinary spectral lines, it is to be expected that multiplicity would be readily revealed in the constituents produced by the magnetic field; yet in the case of some lines, the amount of finer structure revealed does not appear to be as great as that observed with a good grating. . . ." In reply to

this statement, I would say that I know of no such instance. If there are cases of lines showing structure by the ordinary grating, which I do not mention, it is simply that my attention has not been directed to them, and I should venture to guarantee that if observed by either the interferometer or the echelon, they must show the same structure—or a finer.

I should have thought the tripling of the middle green line in the case of the green mercury and cadmium lines a matter of sufficient importance to add to those figured in Mr. Preston's paper.

To illustrate the preceding remarks, as well as to show the performance of the interferometer, I present a figure showing the three types of Zeeman effect, and another showing how these results are confirmed by the echelon.

It will be observed that there is an indication of structure in the outer lines, but at this time they had not actually been resolved. This has since been accomplished, as shown in the following figure :—

FIG. 3.

The following is a list of the radiations thus far examined, and their classifications according to these types :—

Mercury... ...	Yellow lines... ...	Type I.
	Green line	,, III.
	Violet line	,, II.
Cadmium ...	Red line	,, I.
	Green line	,, III.
	Blue line	,, II.
Zinc	Red line	,, I.
(? Cadmium) ...	Green line	,, III.
	Blue line	,, II.
Sodium	Yellow lines... ...	,, II.
Thallium ...	Green line	,, II. (doubtful)
Lithium	Red line	Broadened.
[1]Hydrogen ...	Red line	Broadened.
Helium	Yellow line	Broadened.
	Green line	Type I.
Gold	Yellow line	,, II.
	Green line	,, I.
Silver	Yellow line	,, I.
	Green line	,, I.
[2]Copper	Yellow line	,, IV.
	Green lines	,, I.
Magnesium ...	Green line (5183)...	,, III.
	Green line (5172)...	,, II.
	Green line (5167)...	,, I.
[2]Manganese ..	Green line (5340)...	,, IV.
Argon	Red line	,, I.
Tin	Red line (6450) ...	,, II.
	Yellow line (5798)	,, I.
	Yellow line (5587)	,, I.
	Yellow line (5564)	,, I.
Iron	Most lines	,, I.
Carbon	Component lines of banded spectrum	Unaffected.

The University of Chicago Ryerson Physical Laboratory, Feb. 9. A. A. MICHELSON.

[1] Since this list was first published, decided indications of structure have been noticed, especially in the broadened middle line, which under favourable conditions appears as a group of six or seven very fine lines just resolvable, brightest at the centre, and extending through the entire space between the outer groups. Similar indications, though less distinct, were traced in the outer groups.

[2] Type IV. was added to include cases where a broad or complex line was simplified or narrowed in the magnetic field. This, as regards the copper line and the manganese line, is true of the central line of the triplet, and not (as might be inferred from the original paper) of the whole group.

Attraction in a Spherical Hollow.

THE theorem you published in your number of January 19, under the above head, may easily be deduced from the parallelogram of forces put in this form :

Let σa be intensity and direction of an attractive force, σb both for a repulsing force ; then the resultant of the two forces in σ will be parallel and equal to ba. LANG.

Vienna, February 18.

THE REPORT OF THE SELECT COMMITTEE ON THE SCIENCE AND ART DEPARTMENT.

IN the course of last year the newspapers contained an account of the doings of the Select Committee of the House of Commons appointed to inquire into, and report upon, the administration of the Museums of the Science and Art Department. It was an open secret that some of the members of that Committee were bitterly opposed to the officials of the Department ; but however this might be, all evidence tending to throw discredit was very widely reported long before the Report was issued.

The Report of the Committee in due time made its appearance, and it has now been considered by the Lords of the Committee on Education. The result has been embodied in the shape of the following Minute, which has just been distributed among the Members of the House of Commons and others.

By the Right Honourable the Lords of the Committee of Her Majesty's most Honourable Privy Council on Education.

Present :—His Grace the Duke of Devonshire, K.G., Lord President of the Council ; the Right Hon. Sir John E. Gorst, M.P., Vice-President of the Committee of Council on Education.

(1) The Lords of the Committee of Council on Education consider the Second Report from the Select Committee of 1898 appointed to inquire into and report upon the administration and cost of the Museums of the Science and Art Department. My Lords have also before them the observations on this Report prepared in accordance with their instructions by the Secretary of the Science and Art Department, a copy of which is appended to this Minute.

(2) A reference to the proceedings of the Committee shows that pp. 1 to 16 of the Report are based upon the Chairman's draft. This part of the Report appears to contain a correct statement of facts, but it is followed by paragraphs, introduced as amendments, which traverse to a great extent the same ground, and contain many inaccuracies and some inconsistencies.

(3) Having regard to passages which appear to reflect on individual officers, My Lords desire to emphasise the fact that they alone are responsible to Parliament for the administration of the Museums, and to declare that their directions have been loyally carried out by the staff, and that they retain the fullest confidence in Sir John Donnelly and his colleagues.

(4) They regret that the Committee should have insinuated in their Report that officers have been appointed because of their relationship to members of the staff, and have been dismissed because of the evidence they gave to the Committee. Such insinuations are devoid of any foundation in fact.

By order of the Committee of Council on Education.

SCIENCE AT LIVERPOOL.

THE Lord Mayor of Liverpool is to be congratulated upon a new departure. The Municipal authorities of one of our most important cities have actually held high festival in honour of a man of science, the occasion being the award of the Rumford Medal to Prof. Lodge. The Lord Mayor in the course of his speech said :

"Prof. Lodge was appointed to Liverpool University College in 1881, and since that time he had been closely associated with the work of the institution and done much to advance its reputation. Those who had come under the guidance and instruction of Prof. Lodge testified uniformly to his urbanity, courtesy, and kindness, and to the clearness and completeness of the instruction which he afforded them, but, apart from that, the original experimental work of Prof. Lodge entitled him to the greatest distinction. Their guest was a many-sided man, but the irreproachable certificate of his excellency as a man of science he received when he was awarded the Rumford Medal by the Royal Society. As to Prof. Lodge's attachment to Liverpool, it was so far back as 1881 that they were fortunate enough to secure association with him, and, notwithstanding temptations—some they knew of, and others of which they did not know—he had remained faithful to Liverpool. He thought he voiced the feelings of his fellow-citizens when he expressed the hope that Prof. Lodge would long continue his work in their midst. University College was an institution of which, with every reason, they were most proud, and he believed that in addition to the instruction which was there imparted, the taste of the community was directly raised, and the relations of the community to thought were very considerably ennobled by the existence of the college in their midst. The honour done to Prof. Lodge by awarding him the Rumford Medal was emphasised by the presence that night of some of the foremost men of science—Sir William Crookes, Prof. Fitzgerald, Prof. Myers, and others. If it required any further emphasis, it would have been afforded by the letters which he had received from some of the most prominent men of the time, in which they all expressed their deep regret at not being able to be present to do honour to their distinguished guest."

The Lord Mayor in conclusion alluded to the necessity for the erection and endowment of a physical laboratory at University College, and expressed the hope that before long one worthy of the institution would be provided, in which Prof. Lodge could carry on his important scientific work.

Prof. Lodge said he could not adequately express his sense of gratitude to the Lord Mayor for his speech—a speech of transparent sincerity—whether he deserved it or not. The chief magistrate had spoken about the endowment of a physical laboratory. The man or men who endowed such a laboratory in Liverpool would be doing a tremendous piece of work for the advancement of science. They of University College felt greatly indebted to the Lord Mayor for that magnificent reception and entertainment, and they rejoiced in the links that were every year drawing closer the city and University College. The contact could not be too close. He desired to take that opportunity of expressing his deep sense of the extreme kindness which had been shown to him during the time he had been in Liverpool. A few of his friends had gone, and amongst others, George Holt. No one helped him more directly in his scientific work than George Holt. The requirements of a man of science were not only friendly, but, unfortunately, they were also material, and it was a great thing that citizens of Liverpool and other places helped men of science to do their work. That was what George Holt and others had done, and what he believed others would do. The gathering that night was a remarkable proof of the amount of good feeling and appreciation shown by scientific men for the magnificent act of the Lord Mayor in doing honour to science, for the honour was really done to the Rumford Medal of the Royal Society. The chief magistrate of Liverpool recognised in the Royal Society the fountain of all purely scientific honour in this country, and he also recognised the biennial award of the Rumford Medal as an event of national—nay, even sometimes of international importance—because it was often given to foreigners, and in this way promoted friendly feeling among the workers in science in different parts of the world. It was undoubtedly a great honour to receive the Rumford Medal, and he was astonished when he got the intimation that by some concatenation of circumstances it had been awarded to him. After a reference to the splendid work done in connection with University College by Dr. Rendal, the former principal, Prof. Lodge concluded by saying that they in this peaceful and prosperous time had inherited the fruits of the labours of thousands who had gone before, and as the Lord Mayor had reminded them, they owed a great deal to the splendid era of peace through which they had lived, for it had given them an insight into the processes of nature more deeply than ever it was possible before. Science was yet in its infancy, human civilisation was but emerging from its cradle, the smoke and the noise and the squalor outside were evidences that we had not proceeded far on the road to civilisation; but we had made a start—a secure start, he hoped, this time—and he thought the human race would not again fall back.

Principal Glazebrook, speaking later, said that the estimated cost of a physical laboratory for Liverpool was between 30,000*l.* and 40,000*l.* One generous donor who at present wished to remain unknown had promised 10,000*l.*, and that night Sir John Brunner had offered 5000*l.*, whilst Mr. Alfred Booth had made a challenge offer of 2500*l.* if three other gentlemen would give the same amount.

The dinner, then, has not been without important results, and we hope that such an admirable precedent will be often followed.

AN ANTARCTIC MEETING IN BERLIN.

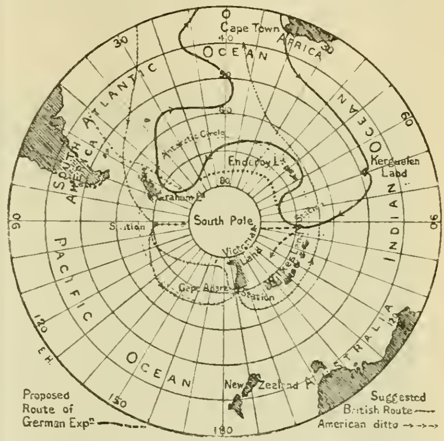
EVER since the idea of despatching a German exploring expedition to the Antarctic was first mooted in 1895, the leading scientific men of that country, headed by the veteran champion of Antarctic research, Dr. Neumayr, have been untiring in their efforts to bring the idea to practical realisation, and one by one most of the preliminary difficulties have been overcome. A year ago the project began to take definite shape, and the important question of the choice of a leader was solved by the adoption as such of Dr. Erich von Drygalski, then on the point of completing his lengthened studies on the inland ice of Greenland. During the past twelvemonth meetings have been held in many of the chief cities of Germany, where the proposals put forward by Dr. Drygalski and others have met with an enthusiastic response. The only remaining obstacle to success is the largeness of the sum required for the expedition, which can hardly be raised by private subscriptions, although these have already reached a considerable amount. It has therefore been necessary to look for Government aid in the matter, and the promoters of the enterprise have met with cordial encouragement in official quarters; but, with a view to further arousing the interest of influential circles in the capital, a combined meeting of the Berlin Geographical Society and of the Berlin-Charlottenburg section of the German Colonial Society was held on January 16 last, under the presidency of Baron von Richthofen, for the purpose of putting before the public the reasons for the despatch of an expedition and the plans which have already been formed for its prosecution.

The meeting, at which many distinguished visitors were present by invitation of the two societies, was opened by a short preliminary address from Baron von Richthofen, who sketched the history of the movement, and gave some account of the previous polar work of the chosen leader. Then, after some remarks by Prince von Arenberg, who represented the Colonial Society, Dr. von Drygalski spoke on the scientific, practical and national importance of the proposed expedition. He began by contrasting the broad features of the North and South Polar regions—the former now known to be occupied by a deep sea, the scattered islands in which form but the outposts of the known continents—while, in the South, men's minds have from very early times pictured the existence of a vast polar continent, the glamour of which long exercised a potent attraction on voyagers, and was finally dissipated only by the discoveries of Cook at the end of the last century. Sketching the progress of discovery since that navigator's time, the speaker laid stress on the important influence exerted by the German

mathematician Gauss, who by his work on terrestrial magnetism gave the impulse to the three expeditions of D'Urville, Wilkes and Ross, to the last of which we owe the whole groundwork of our scientific knowledge of the South Polar region. Although the work of Cook and his successors proved the non-existence of an Antarctic continent valuable from a commercial point of view, it is still the fact that their voyages have—unlike those to the North—brought to light more and more fragments of land, and led to the involuntary conclusion that a continent does lie in those regions.

From a geographical point of view, the fundamental problem attached to the South Polar region—the verification or disproof of the existence of such a continent—is still unsolved. No less important questions likewise await solution with respect to the geological structure and character of the southern lands—so important in connection with a knowledge of volcanic action and the supposed former connection of South America with Australia—and with respect to the conditions of inland ice. It was pointed out by the speaker that even the study of the floating ice broken away from the main mass may lead to important conclusions as to its mode of origin, and the nature of the land from which it comes. Other problems to be investigated are: the origin of the cold ocean currents which take their rise in the south; the conditions of atmospheric pressure and temperature in that region; and the questions relating to terrestrial magnetism, which have so important a bearing on the practice of navigation. Lastly, Dr. von Drygalski alluded, like Sir Clements Markham in this country, to the importance of such an expedition from the point of view of practical training to navigators, and the upholding of national prestige; while he also pointed out the advantages of international co-operation by the sending out of simultaneous expeditions.

The section of Dr. von Drygalski's address which will be read with most interest is, perhaps, that relating to the plans which have already been formed for the carrying out of the enterprise. He began by pointing out that the present seems a particularly favourable period for the resumption of South Polar research, by reason of the unusual amount of drift-ice which has within the last few years broken away from the main mass. This, together with the fact that we are now, according to Supan, passing through a warmer temperature-period, should make the next few years unusually favourable to navigation, and suggests as the most suitable starting-point for an expedition the Southern Indian Ocean, where drift ice has been particularly abundant since 1894. Such a choice also fits in well with the suggestions which have been made with regard to an English expedition, the Southern Pacific and Victoria Land having been mentioned as the probable sphere of the latter. Proceeding southwards on about the meridian of Kerguelen Land, and making *en route* the necessary scientific observations of all kinds, the expedition would attempt to reach some land where a winter station could be formed, and where systematic observations would be continued at the edge of the ice-sheet. In the spring an advance would be attempted southwards over the ice and towards the Magnetic Pole. In the autumn a return would be made as far as possible in a westerly direction along the coast-line supposed to be discovered, the programme being completed within about two years from the date of sailing. The accompanying sketch-map, based on one which accompanies the report of the meeting in the *Verhandlungen* of the Berlin Geographical Society, shows the proposed route in accordance with the above programme. On account of the stormy nature of the southern seas, the lines adopted for the construction of the *Fram* will not be suitable, seaworthiness being the first requisite. Ice-pressure is less to be feared in the south than in the north, since the currents radiate outwards instead of inwards; and the necessary strength can be supplied by internal supports. For many reasons it is thought unnecessary to despatch more than *one* ship, one having proved sufficient for recent North Polar voyages, while the movements of one ship are often hampered by the endeavour to keep in company with a consort. Should the vessels separate for the better prosecution of scientific work, there would be two expeditions, not one, and no additional security would be gained. The vessel should be built of wood, both for its advantages in ice-navigation and to allow of undisturbed magnetic observations. These, with those concerned with meteorology, formed the subject of special remarks by Dr. von Bezold, who pointed out the



Sketch-map of South Polar Region.

particular value attaching to such observations in the region in question.

The whole plan of the expedition seems to have been well thought out, and, judging from his previous services to polar research, the scientific work could not be in better hands than those of Dr. von Drygalski. It is to be hoped that the remaining difficulties may speedily be overcome, and that the result may be an important addition, within the next few years, to our scanty knowledge of the southern regions.

THE SIKHIM HIMALAYAS.[1]

OUR ignorance of the Eastern Himalayas is simply astonishing. It is hardly credible that for nearly 1000 miles, from the western extremity of Nepal (long. about 81° E.) to the eastern end of Assam (long. 96° E. there is only the one small tract of Sikhim, barely fifty miles broad, in which the higher mountains are accessible to Europeans. Throughout Nepal and Bhutan and in the wild forest tracts, inhabited by barbarous Indo-Chinese tribes, east of the latter, none of the rulers of British India can show their faces.

But even in the small mountain region that is open to exploration very few travellers take advantage of the opportunities afforded to them. In the book before us, the author justly insists on the great superiority of the Eastern over the Western Himalayas in scenery. Whether he is right or not in calling the magnificent panorama seen from Senchal, close to Darjeeling, "the

[1] "Among the Himalayas." By Major L. A. Waddell, LL.D., F.L.S., &c., Indian Army Medical Corps. Pp. xvi + 452. (Westminster: Constable, 1899.)

grandest snowy landscape in the world," it is certainly questionable whether a grander view is known. One reason amongst others why the prospect of the snowy range from Darjeeling so greatly excels that from Simla, for instance, is that the high snow-clad peaks are only half as far distant from the former as they are from the latter. Nevertheless, the higher Himalayas north of Naini Tal, Mussooree and Simla attract far more European travellers than the higher ranges of Sikhim because of the great difficulty and expense of journeying in the latter country. Where there are practically no roads, no rest-houses, no facilities for the conveyance of baggage or provisions, and only very small and precarious supplies of food, where everything, from tents to cooking-pots, for a traveller and his guides and followers has to be carried by porters brought from a distance, over steep hillsides in dense forest, along precipices only to be climbed by bamboo ladders, and across raging torrents spanned by swaying cane bridges that afford, by the insecurity of their fastenings and the tenuity of their foothold, a lively conception of the approach to the Mahommedan Paradise, it is not surprising that but few travellers care to face the difficulties of the journey. It is true that within the last decade a few bridle roads have been made and rest-houses built, here and there, but still travelling in the interior of Sikhim is by no means so easy as in the Western Himalayas.

Yet Sikhim has many attractions besides its scenery. The fauna and flora are wonderfully rich and interesting; of birds alone nearly 600 species are known to occur, or about as many as are found in the whole of Europe, and the inhabitants afford a remarkable anthropological problem. Major Waddell, the author of the work before us, has peculiar advantages in undertaking a description of the country, for not only has he spent many years in studying the languages, religion and customs of the principal inhabitants, the aboriginal Lepchas who cultivate the lower elevations, and the Tibetans or Bhotias who occupy the higher habitable tracts, but he has also devoted considerable attention to the natural history of the country. He was the author of a very large portion of the *Gazetteer* of Sikhim, to which he contributed an excellent description of Lamaism or Tibetan Buddhism, and also a list, with numerous notes, of the Sikhim birds. Although his present work, "Among the Himalayas," wants the charm of Hooker's delightful "Himalayan Journals," treating of the same area, it contains a good descriptive account of Sikhim, with many excellent illustrations.

The book consists of notes on journeys made at different times through various parts of Sikhim, chiefly by the author himself. He was unfortunately prevented from visiting the Lachen valley and its tributary the Zemu, leading to perhaps the most interesting corner of the country, north of the great snowy mountain Kanchenjunga; and this is particularly to be regretted, because the tract specified has hitherto been very briefly and imperfectly described, though some beautiful photographs were obtained, of which one is now reproduced. Almost all of the routes traversed by Major Waddell had been previously described by Hooker or by other travellers; but the present work adds much useful information, as it is the first written by any one familiar with the languages and customs of the people. The illustrations, chiefly photographs of the scenery and of the people, their dwellings, monasteries, &c., reproduced by some of the processes now so largely used, are not only very numerous, but also well selected and, in the majority of cases, effectively printed. No better representations of Himalayan scenery have ever been published on a small scale.

It is impossible here to discuss the numerous subjects noticed by Major Waddell, but there is one of general interest—Mount Everest—to which he makes an im-

portant contribution. In the first place he not only confirms, by clear and independent evidence, the decision accepted by the officers of the Great Trigonometrical Survey of India, that the names such as Gaurisankar, Deodhunga, &c., applied by B. H. Hodgson and H. Schlagintweit to the highest peak of the Himalayas, do not belong to it at all, although the first of them has been extensively used on German maps, but he also shows that there is a Tibetan name *Jomo-kang-kar*, meaning "The Lady White Glacier," which apparently does apply to the culminating peak of the Everest group. Secondly he points out that, according to the Tibetans, there is another mountain, due north of Mount Everest, that exceeds even that peak in height, and must therefore be the highest mountain in the world, unless some other Tibetan peak, as yet unmeasured, exceeds it. Apparently no European has yet set eyes upon this mysterious summit of the upper Lap-chi-kang; its discovery and measurement afford a grand opportunity for a future geographer and explorer. Before quitting this subject, a hope may be expressed that no one will be found so utterly lost to all sense of humour as to adopt the barbarous hybrid term of *Kong-kar-Everest* for the monarch of the Himalayas; it is astounding to find Major Waddell writing calmly of the matter, and apparently without any appreciation of the fact that the name is absurd. This is the more surprising, for Major Waddell is justly severe on the ignorance which insists on adding superfluous aspirates and other letters to native names, and he reproves the people who write "Thibetian" for Tibetan and "Gnathong" for Na-tang.

Major Waddell has paid great attention to Sikhimese birds, but he appears to have a rather imperfect acquaintance with the mammals. He writes of the "marsh-deer or sambhar" (p. 260) apparently under the idea that both are names applied to the same animal, he calls the *Goomcher* or *Gumchen* of Tibetans a tailless rat or marmot, whereas it is a *Lagomys* or pika, and he even writes of the Serow, a goat-antelope, as the Serow deer. He must have been misled by some of his followers into supposing (p. 113) that tracks he saw on Tendong, a few miles north of Darjeeling, in oak and magnolia forests, about 8500 feet above the sea, were those of Bharal, *Ovis nahura*, an animal that does not inhabit this part of Sikhim, and that never enters forests at all. It may be added that, especially with regard to Latin names, the book appears not to have been read quite as carefully as is necessary, for *Ovis nahura* becomes *Ovis nehur* on p. 113, and *Ovis natura* on pp. 216 and 225; whilst *Nectrogale* for *Nectogale* (p. 219), *caerulus* for *caeruleus* (pp. 77, 240), *Grandula* for *Grandala* (p. 216), and *Calliophis* for *Callophis* (p. 77), are other instances of misprints. To some extent names of places suffer from the same want of revision; thus the Sibu Pass of the map and Seeboo Pass of p. 215, is apparently the Sherboo Pass at p. 161. Another curious case of oversight is the statement, on p. 330, that the peaks of the Everest group are shut out from view at Senchal by a dark ridge, although a figure of the peaks in question, as seen from Senchal, is given on p. 33; the fact being that it is the lower portions of the Everest group, not the peaks, that are shut out.

These, however, are minor drawbacks, and do not prevent the work from being a valuable addition to Himalayan literature. W. T. B.

PROFESSOR SOPHUS LIE.

IT is with much regret that we have to announce the death of this distinguished Norwegian mathematician, which took place on February 18 of the present year.

Born at Christiania on December 12, 1842, he graduated as Doctor in the University of that city in 1868. Four years later he was appointed professor extraordinarius of mathematics; and in 1886 he succeeded Klein as professor at Leipzig, when the latter was nominated to Göttingen. During the last few years a strong desire has been felt by his fellow-countrymen that he should occupy a professorship in his native country, and that a post should be specially created for him in Christiania. It was only quite recently that this desire had been gratified; unhappily too late to be effective. His strength had been undermined by the intense ardour with which he pursued his investigations; and his health, thus broken, has forbidden any long tenure of a chair in which, as had been hoped, he would be able to continue his mathematical researches.

When once the merit of his work began to be recognised, scientific honours were bestowed upon him freely. He had received the honorary or foreign membership of societies and academies in great numbers; in particular, in England alone, he was enrolled among the foreign members of the Royal Society, and among the honorary members of the Cambridge Philosophical Society and the London Mathematical Society.

The list of his scientific productions includes over 100 papers, many of them of considerable length, and six volumes. Probably he will be best known by the treatise "Theorie der Transformationsgruppen," in the preparation of which he was assisted by the loyal devotion of Dr. F. Engel. It is a work of great originality, containing many methods and a wide range of development; it exhibits in masterly manner the suggestive application of new methods to fundamental subjects; and it may be described briefly as a systematic exposition of Lie's investigations on groups of transformations that are continuous and finite. Among the subjects to which application is made, may be mentioned the theory of ordinary differential equations; the theory of partial differential equations, both single and in systems; differential invariants and their types; the solution of Pfaff's problem; tangential transformations, specially in spaces of two and three dimensions, and more generally in n dimensions; groups of functions transformable into one another, and a substantial simplification (by the use of their properties) in the integration of systems of partial differential equations; a complete determination of types of the groups of transformation in one, two, and three variables, and a partial determination of those in n variables. It concludes with a profound study of the foundations of geometry from the point of view of Riemann and Helmholtz; and after a critical discussion of the significance of the hypotheses which they made, he propounds a solution of his own, based upon more elementary hypotheses.

In a couple of instances, his lectures in amplification and elucidation of portions of his theory were edited and published in volume form by Dr. G. Scheffers, whose help is gratefully acknowledged: one of these relates to differential equations that admit of known infinitesimal transformations; the other to continuous groups.

Two other works were promised by him. One of these, to be written in co-operation with Dr. Engel, was to deal with the theory of infinite continuous groups and the application of the general group-theory to the integration of differential equations: this work has not appeared. The other, to be written in co-operation with Dr. Scheffers, was to be devoted to a systematic exposition of his geometrical investigations; the first volume has appeared under the title, "Geometrie der Berührungstransformationen."

As already indicated, his name at the present time would probably be associated most closely with the theory of continuous groups. An inspection of his memoirs, however slight, is sufficient to indicate his keen and essential interest in the domain of geometry. But while his method was that of the group-theory, and while his investigations so frequently referred to geo-

metry, his real aim is declared by Klein—and the declaration can find ample support from his memoirs and his treatises—to have been the achievement of progress in the theory of differential equations. It was for this purpose that he developed his theory of transformations, and worked at it from his earliest productive days to his latest with a consistent tenacity characteristic alike of the nature and the strength of his mathematical genius.

The death of Sophus Lie removes from the rank of active workers in pure mathematics one of the most conspicuous, independent, and original minds of his generation.

A. R. F.

NOTES.

The Joint Committee of the Royal Society and the Royal Geographical Society, appointed to promote the project of an Antarctic Expedition, have made recommendations to the Royal Society Council and to the Council of the British Association, in pursuance of which the Treasurer of the Royal Society has applied on behalf of the Council to the Government Grant Committee for 1000*l.*, and the Council of the British Association has resolved to recommend to the General Committee to contribute a like amount towards the expenses of the proposed undertaking.

The Croonian Lecture will be given at the Royal Society on Thursday next, March 16, by Dr. Burdon-Sanderson, F.R.S. Subject—"The Electrical Concomitants of Motion in Animals and Plants."

A meeting of the committee of the Liverpool Association of Foreign Consuls was held on February 27, in the office of the Brazilian Consulate, for the purpose of taking into consideration the Liverpool School of Tropical Diseases and its recognition by the Governments represented. The company having been addressed by Mr. Alfred L. Jones, as representing the Congo Free State, and by Mr. Ehrenberg, consul for Sweden and Norway, it was agreed to hold a general meeting of the consuls on March 9, so that they might be better able to inform their Governments on the subject. Prof. Boyce then explained that four courses of two months each would be given to qualified men every year. Liverpool, he thought, was the best possible place in which to establish such a school, as they had examples of the diseases in question brought from all the tropical regions of the world. Besides instructing qualified medical men who would have appointments on shipboard, or intended to practise in tropical countries, they would admit missionaries to the classes, and would also train black women as nurses.

Being invited to take part in the opening of the new School of Tropical Diseases at Liverpool, Prof. Koch has written regretting his inability to be present, and saying: "Permit me to express my sympathy with the new institution and to offer my best wishes for the success of your grand and useful undertaking. I certainly hope to be able later to have the opportunity to personally visit the new institution." In another letter the professor says: "Blackwater fever is the most important disease in West Africa, but one which, I am convinced, it will be easy to prevent when the course and character of the disease become more familiar. Up to the present we have received, with very few exceptions, very satisfactory accounts. Those practitioners in the tropics who have written, give nothing more than anecdotary reports of no scientific value whatever. It will be one of the most important duties of the new school to give medical men going out to the tropics a clear idea of the disease, and to impress on them how to make and collect scientific and useful observations. You in Liverpool have opportunities of seeing cases; even here in Germany I have seen five cases (two in Berlin) during the last half-year in persons who have returned from the tropics."

We are informed by the Secretary of the Institution of Electrical Engineers that, as many members and others failed to gain admission to the meeting on March 2, Mr. Marconi has promised, at the request of the Council, to repeat his lecture on wireless telegraphy, with demonstration, on Thursday, March 16, in the theatre of the Examination Hall, Victoria Embankment. Up to 7.45 p.m. admission will be only by tickets, to be obtained by members on application to the Secretary.

The Royal Institution Friday evening discourse on March 10 is on "Measuring Extreme Temperatures," by Prof. H. L. Callendar, F.R.S.; that on March 17 is on "The Electric Fish of the Nile," by Prof. Francis Gotch, F.R.S.; and that on March 24 on "Transparency and Opacity," by Lord Rayleigh, F.R.S.

The new laboratories in connection with the Middlesex Hospital Medical School are, we hear, now completed. They are equipped with all the best modern appliances for the purpose of instruction and original research. An inaugural conversazione will be held on the evening of Wednesday, March 15, in the new buildings, when many objects of interest will be exhibited.

The President of the Board of Trade has consented to receive a deputation of representatives from the Decimal Association, Chambers of Commerce, Educational Institutions, and Trades Unions on March 22, when the Government will be urged to make compulsory the use of the metric weights and measures after a period of two years, January 1, 1901, having been suggested as a suitable date for the introduction of the new system.

The Fothergillian gold medal for 1899 has, on the recommendation of a special committee of the Medical Society of London, been awarded to Dr. S. Monckton Copeman "in recognition of his researches on the preservative effects of glycerine upon vaccine lymph and of the benefits in a practical sense that have arisen therefrom."

Science announces that the House Committee on Appropriations has recommended an increase of 4200 dollars in the annual appropriation for scientific work of the United States Fish Commission. This increase is made after an examination of the practical results that have attended the lines of scientific research carried on during the past year.

A Bill has been introduced into the New York Assembly appropriating 30,000 dollars to continue the promotion of the sugar beet industry. Of this amount 2500 dollars are devoted to making experiments by the Commissioner of Agriculture.

It is reported that a committee has been appointed by the Council of the Institution of Electrical Engineers to inquire into the future of electrical engineering in the domain of telephony in this country.

On November 17, 1897, the sum of twenty thousand dollars was given to the National Academy of Sciences, as trustee, to establish a fund to be known as the Benjamin Apthorp Gould Fund, in memory of the father of the donor, Miss Alice Bache Gould, the income to be used to assist the prosecution of researches in astronomy. A sufficient available income has now accrued from the fund to warrant beginning its distribution, and the Directors are prepared to receive and consider applications for appropriations. In accordance with the wish of the donor, work in the astronomy of precision shall, in all cases, be given the preference over any work in astrophysics. The fund is in-

tended for the advancement and not for the diffusion of scientific knowledge, and is to be used to defray the actual expenses of investigation, rather than for the personal support of the investigator during the time of his researches, without absolutely excluding the latter use under the most exceptional circumstances. Although intended primarily to assist American investigators, foreign workers may occasionally receive benefit from the fund. Application for appropriations from the income of the fund should be made by letter to the Directors, at 16 Craigie Street, Cambridge, Mass., U.S.A., stating the amount desired, the nature of the proposed investigation, and the manner in which the appropriation is to be expended.

THE National Geographic Society of America offers two prizes of 150 dollars and 75 dollars respectively for the best essays on Norse discoveries in America. Essays submitted in competition must be type-written in the English language, not exceed 6000 words in length, be signed by a pseudonym, and received not later than December 31 of the present year.

PLANS have been made for the erection of a State meteorological station on the summit of Schneekope, one of the Riesengebirge, Silesia, which is 1605 metres in height.

Science states that in the Museum of the Brooklyn Institute a department will be established in which natural history and technology will be exhibited in a manner that will interest and instruct children. This, according to our contemporary, is a new departure for America.

THE *Times* correspondent in Zürich writes that a Volta commemoration is to be held in May next at Como, where the great electrician was born, and where he died in 1827. The *fêtes* at Como are to celebrate the centenary of Volta's discovery of the electric pile. in honour of which event an exhibition of inventions in electricity will be opened on May 14, the town contributing some 500,000 francs to the preliminary expenses. Como has always been proud of its greatest citizen, and Volta's memorials are carefully preserved in its Museo Civico, where can be seen his first electric pile, many of his scientific instruments, an electric pistol, and an electric lamp of his invention, besides many of his manuscripts, sketches, and designs. Exhibits are announced from all parts of Europe and America, and a congress of electricians and telegraphists will be held at the same time. In connection with the Volta commemoration an exhibition of Italian silk industries will be opened simultaneously with the electric exhibition. The exhibition buildings face the lake, on which the latest inventions in electric boats and launches will form a conspicuous feature of the *fêtes*. Volta's electric pile was first described in England in a letter to Sir J. Banks, then president of the Royal Society. This letter is dated March 1, 1800, and was read before the Society on June 26 of the same year.

ACCORDING to *Engineering* the Belgian Society of Electricians is organising an electrical exhibition to be held at Brussels next June, in the Central Telephone Building, Rue de la Paille. The scope of this exhibition is a small one, as it is intended to illustrate only the domestic applications of electricity, but it promises to be one of great interest. The contents will be divided into two sections, and fourteen classes. The first section comprises four classes as follows: (1) Lighting. (2) Electric heating. (3) Power. (4) Batteries and accumulators. including every variety of primary and secondary cells. The second section includes ten classes. (5) Telephones and telegraphs, especially adapted for private service. (6) Safety and control apparatus. (7) Clocks, chronographs, and other similar instruments. (8) Hygiene. (9) Medical electricity. (10) Miscellaneous, such as lightning conductors, luminous signs, the seasoning of wines and alcohols electrically. (11) Music. (12) Electric locks and other safety devices. (13) Electric toys and jewellery. (14) The combination of furniture and decoration with electrical appliances. No generators will be admitted for exhibition, but current will be supplied gratuitously to all exhibitors. A charge for space will be made, varying according to the location allotted. and whether isolated or grouped. Further information respecting the exhibition can be obtained by application to the Secretary of the Executive Committee, 18 Rue Melsens, Brussels.

THE tenth meeting of the International Congress of Hygiene and Demography will be held in Paris in August 1900. The division of Hygiene will comprise seven sections, of which the following is a list: (1) Microbiology and parasitology applied to hygiene, in which the questions to be discussed are the measurement of the activity of serums; the prophylaxis and preventive treatment of diphtheria; meat poisoning, its causes and the means of its prevention; pathogenic microbes in soil and water (cholera, typhoid fever, and other diseases); the part played by water and by vegetables in the etiology of intestinal helminthiasis. (2) Chemical and veterinary sciences applied to hygiene; alimentary hygiene, in which the questions to be discussed are tinned provisions and the means of preventing accidents: unification of international control; the establishment of a general and uniform system of inspection of slaughter-houses, &c. (3) Engineering and architecture applied to hygiene, in which the question to be discussed is the protection of water supplies. (4) Personal hygiene, in which the question to be discussed is contagious patients from the hospital point of view. (5) Industrial and professional hygiene. (6) Military, naval, and colonial hygiene, in which the question to be discussed is the means of ensuring the purity of water from the point of view of colonial hygiene. (7) General and international hygiene (prophylaxis of communicable diseases; sanitary administration and legislation), in which the questions to be discussed are the prophylaxis of tuberculosis in regard to individuals, families, &c.; the compulsory notification of communicable diseases, its necessary consequences (isolation, disinfection) and its results in different countries; the prophylaxis of syphilis; and the international prophylaxis of yellow fever.

ON Sunday morning, at about twenty minutes past two, a disastrous explosion occurred at the Lagouban Naval Magazine, which is situated on a hillside about two and a quarter miles from Toulon. It is said that the magazine contained 50,000 kilogrammes (or nearly fifty tons) of black powder; and, as every one agrees that only one report was heard, the whole must have been blown up simultaneously. Many of the effects of the explosion are of interest. For nearly two miles round, the country has been swept almost bare. Houses are razed to the ground, trees are overturned, or bent and distorted to the most extraordinary shapes, the fields are devastated and covered with stones and fine impalpable black dust. One stone, weighing nearly fifty kilogrammes, fell in the suburb of Pont de Las. Windows were shattered and doors battered in at St. Jean de Var, five miles from Lagouban. The explosion was heard and felt at Nice (84 miles), where it was at first supposed by some to be a slight earthquake; and it is also said to have been felt across the frontier at Ventimiglia, which is at a distance of about 98 miles.

AT a meeting of the Society of Arts, on the 17th ult., the Rev. J. M. Bacon read a valuable paper on the balloon as an instrument of scientific research. The author reviewed the subject from the time of the ascents organised by the Russian Academy at the beginning of this century, until the recent researches under the auspices of the international organisation now in active progress in various countries, and including the

experiments with unmanned balloons and with kites. He very properly attached much importance to the work carried on in 1852, under the auspices of the British Association, by Mr. J. Welsh, of the Kew Observatory, and by Mr. J. Glaisher ten years later. The primary objects of the exhaustive researches of the latter were to determine the temperature and hygrometric condition of the air below the clouds, in them and above them. These ascents clearly proved that the decrease of temperature with elevation is far from constant, and that during the midnight hours there is generally an increase of several degrees. The experiments with unmanned balloons, which have ascended far beyond the limits of human endurance, have brought down readings showing altitudes and temperatures never dreamed of. In those conducted at Berlin an altitude of upwards of 60,000 feet has been reached, and a temperature of −88 was recorded; while a temperature of 6° lower has been recorded in a similar balloon despatched from Paris. The author draws attention to important results obtained with regard to the motions of the atmosphere, and the transmission of sound waves.

At the recently held annual meeting of the Washington Academy of Sciences, Prof. Charles D. Walcott was elected president for the ensuing year. A course of popular lectures on scientific subjects has been arranged for delivery during March and April, and a number of demonstrations will also be given on topics of special interest. The Academy has decided to publish its proceedings. The "brochure" plan has been adopted; each separate publication will have its own pagination as well as that of the volume, and be dated with the actual date of delivery to members. A welcome donation to the Academy was recently made by Mrs. G. Hubbard, of the value of 1000 dollars, as a token of her desire to aid in the advancement of science and the union of scientific interests in Washington.

It is stated in *Science* that Dr. Charles Mohr, special agent of the Forestry Division of the United States Department of Agriculture, has recently presented to the Museum of Pharmacognosy of the University of Michigan some interesting and valuable specimens. They consist of a section of a pine-tree trunk, showing the American method of boxing and bleeding long-leafed pines for turpentine, and of samples of the twenty different turpentine products manufactured in the South. The various stages of the manufacture of turpentine are, it is said, well illustrated by these specimens.

The *Geographical Journal* for March, speaking of the German Deep-Sea Expedition, says that a letter from Prof. Chun, the leader of the expedition, dated January 20, has reached Sir John Murray, from which it appears that the voyage of the *Valdivia* down the Atlantic to the edge of the Antarctic ice, and thence through the Indian Ocean, has been most successful, the soundings alone serving to fill an important gap on the charts, and showing that the average depth of the Southern Ocean must be considerably greater than has been supposed. The *Journal* says that Sir John Murray considers that the success of the German investigators in attaining so high a southerly latitude, as is mentioned in the letter, in a vessel not protected for ice-navigation is very remarkable, and that it augurs well for the prospects of a scientific Antarctic expedition. Prof. Chun's communication, which is printed in full in the *Journal*, states that Dr. Bachmann, the surgeon to the expedition, died in the Indian Ocean, but that all the other members of the party were well.

Sir Charles Todd has communicated to the *South Australian Register*, of January 14, a review of the weather of South Australia during the year 1898. He states that, although owing to dry weather at the beginning and end of the year, as well as in September, when the failure of rain was fatal to the harvest in many parts of the Upper North, more rain fell over the settled districts generally than during the two previous years. June was the wettest June in the north on record at all stations. As regards temperature, it was below the average during the first five months of the year in the northern and central parts, and above the average during the rest of the year; while in the extreme south it was generally warmer than the average all through the year. Altogether the harvest season has turned out a very fair one: a great improvement on the past two or three years.

In the *Meteorologische Zeitschrift* for January, Dr. J. Hann has contributed a short paper on the climate of the Klondike district, collated from observations at present available. The following are the values for temperature at Dawson City during four months of January: means of the daily extremes (minima and maxima) −26°·1, −17°·0; means of the monthly extremes −54°·6, 12°·7; the absolute extremes are −67°·9, 21°·9. For July only one month is available: the mean daily extremes are 44°·4 and 68°·9, and the mean monthly extremes are 32°·9 and 81°·0. These values are not out of the way for a continental climate in such a high latitude (64° 5′ N.); they do not compare with the low winter and high summer temperatures in the same latitude of East Siberia.

A description of the Vertebrate remains from the Port Kennedy Bone Deposit was the last scientific work of the late Prof. E. D. Cope, and it has now been published in the *Journal* of the Academy of Natural Sciences of Philadelphia (vol. xi. part 2, 1899). The MS. has been printed just as it left the hands of the author, and such of the fossils as it was necessary to figure have been illustrated in four plates by a photographic process. Curiously enough no other fissure or bone-cave has yielded such a large number of species as this cave or fissure at Port Kennedy, which is situated in Upper Merion Township, Montgomery County, Pennsylvania. So long ago as 1871 its ossiferous nature was discovered by workmen engaged in quarrying the Cambrian limestone in which the fissure occurs, and many of the fossil remains were then identified by Prof. Cope. The palæontological interest of the locality was, however, for more than twenty years lost sight of, until Mr. H. M. Mercer and others engaged in careful excavations, and obtained materials for the full report which is now issued. The assemblage is a remarkable one. Tiny Mammalia such as shrews, and voles occur alongside of the mastodon and giant sloth. Remains of horse, tapir, peccary, and porcupine occur together with machærodus, lynx, wolverine, wolf, and bear. Semi-terrestrial forms of tortoise, snake, and beaver are found with the hare, squirrel, and jumping mouse. The majority of the forms are not in any sense cave-dwellers, nor could they well have been dragged there by carnivorous species. The bones are neither gnawed nor water-worn. At the same time, two bones have been rarely found in their normal relations to the skeleton. As stated in a previous report (*Proc.* Acad. Nat. Sc. Philad. for 1895, p. 450), Prof. Cope believed that the larger animals fell into the fissure at intervals during a long period, while many of the smaller ones may have entered it by channels now filled with debris; and Prof. A. Heilprin (p. 451) thought that the large number of extinct or Neotropical forms, indicated more nearly a Pliocene than a Post-Pliocene (or Pleistocene) fauna—at all events a fauna which preceded the glacial epoch.

The additions to the Zoological Society's Gardens during the past week include a Smooth-headed Capuchin (*Cebus monachus*, ♂) from South-east Brazil, presented by Mrs. Cecil Popham; a Sooty Mangabey (*Cercocebus fuliginosus*, ♀) from West Africa, presented by Lieut. B. Horsburgh, A.S.C.; a

Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Mr. R. C. Cooper; a Wild Cat (*Felis catus*) from Scotland, presented by Mr. Claude Alexander; a Silver Pheasant (*Euplocamus nycthemerus*, ♂) from China, presented by Mr. W. McNaughton Love; two Thars (*Hemitragus jemlaicus*, ♂ ♀) from the Himalayas; a Long-billed Butcher Crow (*Cracticus destructor*) from New Holland; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, deposited; a Thick-tailed Opossum (*Didelphys crassicaudata*, ♀) from La Plata, a White-eyebrowed Guan (*Penelope superciliaris*) from South-east Brazil, a Little Guan (*Ortalis motmot*) from Guiana, three Elliot's Pheasants (*Phasianus ellioti*, ♂ ♀ ♀) from China, purchased.

OUR ASTRONOMICAL COLUMN.

Comet 1899 *a* (Swift).—Three telegrams have been received from Kiel announcing the discovery of the first new comet of this year. Two observations of it appear to have been made, the respective positions being as follows:—

1899.	R.A. h. m. s.	Decl. ° ′ ″
March 3	3 45 0	−29 0 0
4	3 48 0	−27 7 0
6	3 37 8	−24 8 32

It is described as being bright enough to be seen with the naked eye, and having a slow movement.

The comet should be looked for immediately after sunset in the south-eastern sky. At present it is about 12° due south of the 2nd magnitude star γ Eridani, passing the meridian about 5.30 p.m. As a guide to its position, it is nearly on the line joining α and β Orionis, about twice as far from the latter as these two stars are apart.

Tuttle's Comet.—Another telegram from Kiel communicates an ephemeris of this comet, which has been computed by J. Rahts from data obtained in 1885.

Ephemeris for 12h. M.T. Berlin.

1899.	R.A. h. m. s.	Decl. ° ′	Br.
March 5	0 59 58	+33 36·2	
7	1 7 23	33 17·8	0·62
9	14 51	32 58·5	
11	22 21	32 38·2	0·66
13	29 52	32 16·9	
15	37 25	31 54·4	0·70
17	45 0	31 30·8	
19	1 52 35	31 6·2	0·75
21	2 0 10	30 40·0	
23	7 47	30 12·8	0·80
25	15 23	29 44·2	
27	2 23 0	+29 14·4	0·86

The brightness, in terms of its intensity in 1885, August 10, this being unity. The above positions extend from about halfway between α and β Andromedæ to the centre of the constellation Triangulum. It should be looked for soon after sunset.

As we go to press, a telegram has been received announcing the observation by Herr Wolf of a comet sufficiently near the position given in the above ephemeris to suggest its being the same. The coordinates are as follows:—

1899. d. h.	R.A. h. m. s.	Decl. ° ′ ″
March 5 11.5	1 16 0	+31 38 0

No information is given concerning the brightness of the comet.

Lowell Observatory.—In "Popular Astronomy," vol. vii. p. 74, Mr. A. E. Douglass gives a *résumé* of the planetary work which has been done at the Lowell Observatory, Flagstaff, Arizona, during the past four years. Observations of Mercury, by Messrs. Lowell and Drew, confirmed Schiaparelli's result that the planet rotates once during its revolution round the sun. Lines of various widths and dark patches were seen. Venus was examined by the same observers, and also found to continuously present the same aspect to the sun. The markings are faint but certain with good seeing. The prevailing straw-colour seen is ascribed to the presence of an atmosphere. Mars has received special attention, Mr. Lowell having found a number of new canals and lakes. Much time was spent in tracing the seasonal changes on the planet. The white South Polar cap was observed to diminish as the equinox approached, and at the same time a dark line formed round it, the grey tint of the south temperate zone assuming a distinct bluish green, strongly suggestive of growing vegetation. Later this zone turned brown, and finally to a slowly lightening yellow.

The frequently observed projections on the terminator are ascribed by Prof. W. H. Pickering to clouds in the Martian atmospheres. These clouds appear to only form during the planet's night; and this, if true, helps to explain the high mean temperature of the planet as was suggested, in 1892, by Prof. Pickering.

Vesta is found to have a polar compression of $\frac{1}{10}$, the major diameter being almost in the direction of its orbit. The markings detected indicate a direct rotation in less than thirty hours. Jupiter's satellites have been carefully observed to compare with the results of Prof. Pickering at Arequipa in 1892. The period of rotation of Satellite I. is found to be 12h. 24·0m.; its ellipticity is perceptibly greater than in 1892, and its mean diameter slightly less. Detail was seen in Satellite II., showing rotation, but no time deduced. Satellites III. and IV. have direct rotation, always presenting the same face to Jupiter.

The paper concludes with a proposal to establish a systematic notation for further expressing the observing conditions under which astronomical work is carried on. The author gives a "scale of seeing," based on the appearance of the stellar image in a lens of six inches aperture.

THE NORTHERN POLYTECHNIC, HOLLOWAY.

To form a correct estimate of the existing provisions for the education of the millions who are crowded into the metropolitan area, it is essential to give an adequate consideration to the work being done by the fifteen separate institutions and branches which are included under the London polytechnics. The buildings in which this work is being accomplished may be estimated to have cost at least half a million sterling in capital outlay, and to be expending about 130,000*l.* annually upon some 50,000 students of the multitude of subjects for which provision is made. The receipts from fees and other miscellaneous sources do not exceed 30,000*l.*, leaving 100,000*l.* to be met from other funds. Private subscriptions probably amount to 10,000*l.* The contributions of the City Companies (principally the Drapers', Goldsmiths', and Skinners') provide some 20,000*l.* more. But at least 70,000*l.*, or about two-thirds of the net cost of the work, is drawn from public funds. The grants of the Science and Art Department may be estimated at 10,000*l.* The Central Governing Body of the City Parochial Charities contributes altogether about 30,000*l.*, and the London County Council, through its Technical Education Board, supplies 30,000*l.*, definitely allocated to the part of the work falling within the statutory definition of technical instruction.

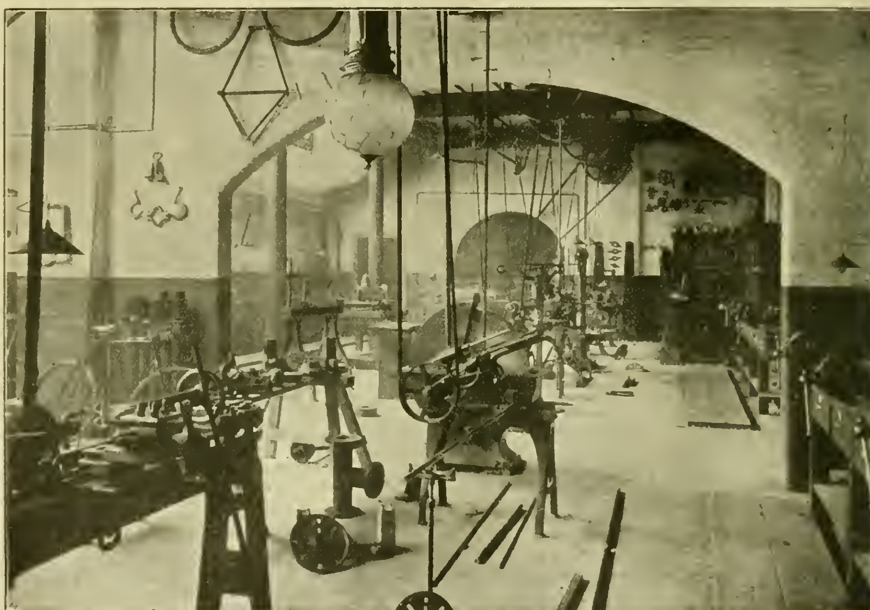
"Each polytechnic institute is an independent organisation, unique in its deliberate combination of social intercourse, recreation and instruction. It is not subject to control by any Government department or other authority, and free, within the limits of its own trust-deed or other constitutional document, to move in whatever direction may be determined on by its governing body." They are, however, with one exception, based upon schemes of the Charity Commission and subject, to a certain extent, to ultimate control by that body. They necessarily defer to any suggestions made by the trustees of the City Parochial Charities, since they, all but two, receive large sums of money from them. The Technical Education Board of the London County Council exerts a very real authority over the educational work carried on in these institutions; for all of them, with two exceptions, are in a great measure dependent upon the large subsidies from this source.

It must not be lost sight of that "in every polytechnic institute the club rooms for men and women respectively, the concerts and entertainments of various sorts, the popular lectures and excursions, form a leading feature. Well-equipped gymnasia and playing-fields, billiards and other games, reading-rooms and lending libraries, as well as mutual societies of all kinds (debating, essay, Shakespeare, swimming, rambling, cycling,

cricket, rowing, photography, and many others), enrol tens of thousands of members." It is to this part of the expenditure that (besides members' fees, and the private subscriptions) part of the contributions from the Parochial City Charities Fund are to be regarded as contributing.

The London Polytechnic is a pure addition to the educational system, neither competing with, nor superseding, previously existing institutions. There is no reason to believe that the alleged stagnation of the London University colleges and secondary schools is in any way connected with the remarkable growth of the polytechnics since 1890.[1]

The Northern Polytechnic Institute[2] was founded under a scheme of the Charity Commissioners, in accordance with the provisions of the City of London Parochial Charities Act, 1892. The scheme provides for the government and administration of an institute for educational and recreative objects, and endows it with an annual sum of 1500*l.* for maintenance, on the supposition that suitable buildings are assured from other sources.



A Laboratory of the Northern Polytechnic.

Subscriptions to the amount of 25,000*l.* were secured for that purpose, largely from private sources, but chiefly through the munificence of the Clothworkers' Company, and a site was obtained in the Holloway Road. Plans for the erection of an institute were prepared in 1893, but, in the first place, only the buildings necessary for educational purposes were erected. The cost of the site was 8500*l.*, and its total area is about one and a quarter acres. The buildings at present completed, at an expenditure of 28,000*l.*, cover some 3400 square yards of the site.

Up to the present some 8000*l.* has been spent upon the equipment of the institute. In every department a fairly complete set of apparatus and fittings for elementary work was provided from the beginning, and instruments for more advanced work have been added, as required, from special equipment grants made by the Technical Education Board of the London County Council.

The income of the Northern Polytechnic is made up as follows: (1) the amount, previously mentioned, received under the City Parochial Charities; (2) special grants made by the Central Governing Body, up to the present amounting to about 500*l.* per annum; (3) grants from the Technical Education Board, amounting for the session 1897–8 to 1900*l.*; (4) grants for attendance, or on the results of examinations, made by the Science and Art Department and the City and Guilds of London Institute, but which, in the absence as yet of a complete working year, cannot be exactly estimated; (5) students' fees, which for the last working year amounted to 1300*l.*; (6) fees received for hire of the large hall, and private subscriptions.

The more important items of expenditure are salaries and wages, 4100*l.*; fuel, light, and water, 500*l.*; advertising, printing, stationery, and postage, 500*l.*; rates and insurance, 200*l.*

The Work of the Northern Polytechnic.

Almost the whole of the work has as yet been carried on in evening classes, but arrangements are to be made for complete courses of study during the day. In the words of the Principal, Dr. J. T. Dunn, "for the most part the work is *Brodstudien*—the object of the students is to gain knowledge which will be of service to them in their daily work, present or prospective, and any mental training which they receive is incidental." Within this limitation, however, every effort is made to co-ordinate the work of the different departments. Thoroughness is aimed at, and the students are encouraged to study cognate subjects bearing upon their own particular work. The artisan is urged to take up the branches of science upon which the practice of his trade depends, and in both the science and technological classes the greatest importance is attached to practical exercises. As in nearly every other technical institute in the country, the value of the work accomplished is very much discounted by the want of general preliminary training exhibited

[1] The reader is referred to Mr. Sidney Webb's able paper in "Special Reports on Educational Subjects," vol. ii., for further general information respecting London polytechnics.

[2] See the excellent illustrated account by Dr. Dunn in the *Record of Technical and Secondary Education*, January 1899.

by the students who present themselves for instruction in science and technology.

Broadly, the work of the evening classes may be grouped under the heads of (1) mathematics and science, (2) technology, (3) commerce and economics. A fair number of students, however, study languages and other literary subjects.

In addition to the classes in the various branches of study included under physics there is a three years' course in electrical engineering, and workshop classes are arranged for the fourth and succeeding years in electric wiring, fitting, &c. Courses in telegraphy and telephony are to be held later to supplement the other work.

Students in the department of engineering begin with elementary machine drawing, and are only admitted to the mechanical engineering lectures after they have made a certain amount of progress in such drawing. There is also workshop practice in fitting and machining, smith-work and pattern-making. Students work for two or three evenings a week in the shops, at a regular course of filing, chipping, scraping, &c., and are not allowed to go to the machines till they have proved their efficiency at hand work.

The department for the building trades is probably the most numerously attended, a natural result of the fact that these trades are strongly represented in the neighbouring localities. An endeavour is made to get all technological students to go through a course of building construction and to acquire an elementary acquaintance with mathematics, practical geometry, and experimental science. A short course of lectures on the chemistry of building materials is given. Classes in builders' quantities and quantity surveying are held, and practical work is done in the brick-work and plumbing shops. A collection of specimens of various woods arranged for students' inspection at any time, and practical work in masonry, plasterers' work, house-painting and decorating, complete the facilities placed at the disposal of all engaged in the building trade.

In addition to a very complete course of lectures and practical work in pure inorganic and organic chemistry, there have been arranged in the chemical department, lectures to trade class students on various technical applications of chemical and physical science, and a course of elementary experimental science, given by the Principal and the Head of the physical department. This simple course forms an introduction to the more systematic work in the chemical and physical departments, as well as providing the necessary preliminary training for students of technology.

The department of commerce and economics at present includes classes in book-keeping, shorthand, type-writing, and general commercial subjects. French and German are also extensively studied.

The women's department is in an undeveloped condition. Needlework, dressmaking, and millinery are the only subjects for which provision has yet been made. With the completion of the new buildings, now being erected, the organisation of classes in cookery, laundry-work, and general housewifery will be brought to perfection, and a day school of domestic economy will be started.

The Northern Polytechnic has, in addition to the students already referred to, a number working for University degrees, and many studying literature, vocal and instrumental music, elocution, and other subjects of a similar more or less recreative character.

The rapid increase of the numbers seeking admission has already raised a difficulty as to accommodation, and for the 2000 individual students at present enrolled every available inch of space has had to be utilised.

A. T. SIMMONS.

THE DUKE OF DEVONSHIRE ON THE SECONDARY EDUCATION BILL.

A DEPUTATION representing a conference held in Manchester under the auspices of the Victoria University on the subject of secondary education, was received on Friday last by the Duke of Devonshire, Lord President of the Council, the object of the deputation being to present to the Lord President the following resolutions, which were passed at the Manchester Conference :—

(1) That, in the opinion of the conference, a Minister of Education of Cabinet rank should represent the Education Department in Parliament ; (2) that the creation of the consultative committee mentioned in Clause 3 of the Bill should be obligatory, and that the committee should be so composed as to be competent to advise as well on the various grades of technical as on those of secondary education ; (3) that it is desirable that immediate provision be made for the institution of local authorities for secondary education ; (4) that the relations of the proposed board of education to the Charity Commissioners should be more clearly defined in the Bill, so as to avoid as far as possible the risk of dual control.

We print, from the *Times* report, an abridgment of the speech delivered by the Duke on the occasion.

As to the resolutions they had brought before him, he was happy to see that the first one practically endorsed the action of the Government in relation to the Bill which was introduced last year. The Bill which will shortly be introduced will probably be altered in some respects as to the constitution of the new Education Department ; but he hoped that such alteration would make it more satisfactory than even the provisions of the Bill of last Session.

The subject upon which Principal Bodington chiefly spoke was that of the second resolution relating to the appointment and constitution of a consultative committee. Principal Bodington said that a certain amount of apprehension had been felt in some quarters that the assumption by the Government of supervision or control over secondary education might possibly have the effect of crushing out the individuality which has hitherto characterised the secondary school system, and might tend in the direction of undue uniformity. He could assure them that no such idea has entered into the minds of the present Government, and that they are perfectly aware, and feel as strongly as it is possible to feel, that it would be in the very highest degree undesirable to attempt, in relation to secondary education, to establish any such uniformity of system as must, perhaps necessarily, exist as regards primary or elementary education. And in so far as the appointment of an advisory committee may tend to make it impossible that any such result may follow, he attached very considerable importance to the constitution of such a committee. Principal Bodington admitted, however—and that is a point on which he felt equally strongly—that the appointment of the committee must not be allowed in any degree to impair the responsibility of the Minister himself.

It would, he thought, be a very unfortunate departure from our constitutional system if the Minister were able to feel that he was not absolutely and entirely responsible for the action of his department, and if he were able to take shelter under the advice of the consultative committee, however representative that committee might be.

As to the constitution of the consultative committee by the Bill to be introduced, he did not think it would be desirable to enter into too minute details. Words, however, he thought, might very well be inserted in the clause setting forth that the intention is to give it that representative character—representative of the Universities, representative of other parties interested in education, representative of the teachers themselves, as well as persons directly nominated by the Government.

Secondary education ought probably in the new department to have a sub-department of its own ; and technical education probably will remain, for the present, at all events, more closely connected with the Science and Art Department. Secondary education is concerned with boys and youths ; technical education is concerned with youths and people of more advanced age ; and he doubted very much whether it would be possible, without unduly enlarging the size of the consultative committee, to entrust to the committee duties connected with both secondary and technical education.

Not much had been said by the deputation on the subject of the third resolution—the institution of local authorities for secondary education. He trusted that anybody who did him the honour to read the speech he made on the subject last year will recognise that the Government are not in the smallest degree insensible to the urgency of the constitution of these authorities. If they refrained this Session from embodying proposals on that subject in the measure which constitutes the central authority, it would be for the reason stated last year.

He could give the strongest assurance that nobody could feel more than the Government that a measure which does not deal with the constitution of local authorities must necessarily be an utterly inadequate and imperfect one, and that it is the Government's firm intention, if they should be successful in passing the

Bill constituting the central authority this year, to introduce one for the constitution of local authorities next year.

The question of the relations of the proposed Board of Education to the Charity Commissioners was an extremely difficult one. He thought the provisions relating to the subject in the Bill of this year might probably differ in some respects from those in last year's Bill; and he hoped that any alterations that might be made in them might be in the direction which the deputation had indicated and appeared to desire. He did not anticipate much difficulty in obtaining assent to the general principle of the Bill. When they came to its details he had no doubt that some difference of opinion might be developed, and he would be very happy to have an opportunity of taking the advice of some of the gentlemen who composed the deputation, and who would be so competent to render it.

THE ORIGIN OF ATMOSPHERIC ELECTRICITY.[1]

ALMOST every suggestion that has ever occurred to any one as to the origin of atmospheric electricity, and the part it plays in meteorology, has been tested over and over again during the past century with only negative results. Some of these are noted in the following paragraphs:

Volta and De Saussure suggested the evaporation of the natural waters on the surface of the globe, all of which are more or less impure, but Pouillet showed that electricity could not come from the evaporation of pure water, but might come from salt water and also from the evaporating surfaces and chemical changes incident to vegetation. De la Rive showed that vegetation was entirely insufficient, and Reiss showed that evaporation of salt water does not, of itself, produce electricity; on the other hand, he showed that the friction of drops of water against the sides of a platinum vessel would produce a small amount.

The hypothesis that our electricity comes from the action of the sun in heating the atmosphere, as also that it is produced by the friction of warm air against cold air, have both been examined, but experiment has never been able to demonstrate the slightest trace of thermo-electricity in gases and vapours.

Schoenbein considered that the oxygen of the air might act electro-chemically upon the molecules of water of which the clouds are composed; but this again has received no experimental confirmation, and could hardly account for the electricity that we find in the clearest dry air. E. Becquerel suggests the decomposition of organic matters; but this, also, is not considered sufficient. It is recognised on all sides that the evaporation of terrestrial waters may carry the negative electricity at the surface of the ground upwards into the atmosphere; but this does not explain the origin of that electrified state at the surface, nor the fact that the atmosphere remains positive while the earth remains negative.

De la Rive considered that the continual chemical action taking place in the interior of the globe explains the origin of terrestrial electricity, and that, as beneath the ocean this action is due to infiltration of sea water, therefore, the ocean is charged with positive electricity, but the solid continents with negative. Especially in the equatorial regions would the atmosphere receive from the sea those positively electrified vapours which, after overflowing into the two hemispheres, would descend in the polar regions and produce auroras, lightning, &c. But this fascinating and comprehensive theory seems to be not at all in harmony with the recent careful observations as to the nature of the electrical distribution in latitude and over oceans and continents. It is generally acknowledged that a great amount of electrified vapour and dust is carried up in every volcanic eruption; but although the quantity is enormous, yet it is not sufficient to explain the condition of the whole atmosphere, although we may thereby explain some of the variations in its general electrified condition; this volcanic electricity apparently originates in a variety of ways, especially from friction.

The fact that a magnetised body when in motion gives rise by induction to an electric current flowing through a neighbouring conductor has led Rowland and S. P. Thompson to calculate the electric effect of motions, such as the wind blowing over the surface of a magnetised globe, or the effect of the rotating magnetic earth upon the ether of space in its neighbourhood. But here again the electric effect turns out to be too small.

[1] By Prof. Cleveland Abbe. (Reprinted from the U.S. *Monthly Weather Review*, June 1898.)

The discovery by Arrhenius that sunlight, especially the ultra-violet rays, greatly diminish the insulating power of dry air and produce what is called photo-electric dissipation and the phenomena discovered by Hallwachs, that a conductor carrying a negative charge gives it up to the surrounding gas when struck by a ray of ultra-violet light, have given rise to the idea that in this way the sunlight acting upon one-half of the earth's atmosphere may discharge the electricity therefrom as well as from the earth and ocean beneath the air; but this, again, has not yet been demonstrated by experiment.

Faraday and Sohncke have shown that dry crystals of ice, such as may occur in the coldest dry air, may become positively electrified by friction, as, for instance, by descending through the air, and Sohncke has formulated a theory explanatory of the electricity of thunderstorms as dependent upon the behaviour of cirrus and cumulus clouds. The electricity is generated in the region of the isothermal surface of 32° F., but this ingenious view still waits for its confirmation. Brillouin has advanced an ingenious explanation of the origin of atmospheric electricity, based upon the action of ultra-violet light upon the crystals of ice that constitute cirrus clouds (see *Monthly Weather Review* for 1897, p. 440), but some points in his theory remain to be established by further experimentation. P. de Heen suggests that as solar radiation illuminates and heats the earth, so it also has the power to electrify the upper strata of air; that these, in fact, as it were, absorb the electric influence, and then, being electrified, act indirectly on the ground below. Maclean and Lenard have studied the electrification of the air by drops of water falling through it. It is found that falling water drops give the air a negative charge, but so also do snow crystals; therefore the higher strata of air should be negative instead of positive, as actually observed. Marvin observes that a rain of fine drops of mercury in dry air electrifies the drops and presumably the air. Palmieri has shown that the condensation of aqueous vapour in and of itself does not develop electricity. Gay Lussac and Pouillet did the same for all changes of condition from solid to fluid to vapour to gas, and the reverse; no electricity is developed except in the change from fluid to solid, when some solids, such as sulphur, show slight manifestations which are due to the action of the edge of the solidifying liquid on the glass vessel containing it.

The inductive action of the earth on its atmosphere is undoubtedly important, but the action of the sun, distant as it is, may be appreciable. Edlund and Siemens have advocated the solar origin of atmospheric electricity, but their hypotheses have not yet been generally accepted.

The spread of the electro-magnetic telegraph lines and the electric cables over the globe has shown that local electric currents generally flowing in an east-west direction exist everywhere in the earth, thus suggesting that the electrified condition of the atmosphere depends upon them. Clerk Maxwell, in his treatise on electricity, after recognising that all other sources are insufficient, suggests that possibly the changing pressures to which the earth's crust is subjected by tidal strains may give rise to piezo-electricity sufficient to explain the negative charge of the earth; the editor, quite independently of Maxwell, has elaborated this hypothesis in his "Preliminary Studies." The laws of these tidal strains have been studied by Chree, Davison, Darwin, and others.

The thermo-electric currents of Peltier and the piezo-electricity so fully investigated by Gaugain are not sufficient to explain the amount of electricity represented by the currents flowing through the earth's surface, but the piezo-electric currents due to tidal strain may be quite sufficient. The latter represent the conversion of gravity into electricity.

Lord Kelvin, without touching the question as to the ultimate origin of the electrified state, shows that observed phenomena are sufficiently explained by simply recognising the fact that the atmosphere can be treated as the dielectric of a condenser (like the glass between the two sheets of tinfoil in a Leyden jar); the lower or earth's surface is negative, and the upper layer of the atmosphere is positively electrified.

But without pursuing further the maze of hypotheses as to the ultimate origin of the electrified state of the atmosphere, we must conclude that this problem is too difficult for immediate solution; it is one of many that a following generation of physicists will undoubtedly cope with successfully.

If we turn to the simpler question of the meteorological phenomena that are evidently associated with atmospheric electricity, we shall find that the best physicists are not yet wholly

clear as to the method of formation of lightning and auroral discharges, the phosphorescent glow of the clouds, ball lightning, and other every-day phenomena. Is a cloud to be considered as one big conductor, or does it insulate and separate the electrified masses on either side of it? Are the great displays to be seen on the summits of the Rocky Mountains due to the influence of the atmosphere or to something going on in the earth beneath? Are large drops really made up by the agglomeration of small cloud particles, or are both the drops and electricity formed simultaneously by the sudden dissipation of unstable molecular equilibrium that exists in supersaturated cloudy air (as suggested by the editor in his article of 1891 in *Agricultural Science* on the "Artificial Production of Rain")? Do the larger drops of rain really possess a greater electrical density on their surfaces than the small drops and particles, or do they not rather lose their charges immediately either by evaporation or by gentle discharge to the neighbouring drops? These and other questions crowd upon our thoughts; but satisfactory replies can only be given after physicists have invented appropriate methods of investigation. Meteorological observers may contribute to the solution of the problems by collecting both general data and special observations of exceptional phenomena, but the discussion of the data and the definitive decision by means of experimentation as to the merits of conflicting hypothetical explanations must be left to the leading physicists of the world.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The election of a professor as member of the Council of the Senate, to fill the place of Prof. Robinson, now Canon of Westminster, will take place on Friday, March 17.

Prof. Woodhead is appointed an Examiner in State Medicine, in the place of the late Dr. Kanthack.

Syndicates are to be appointed to obtain plans and estimates for the new buildings of the Medical School and of the Botanical Department.

MR. FREDERICK TREVES, consulting surgeon to the London Hospital, has been appointed an Emeritus professor of surgery to the London Hospital, and will give a course of lectures in clinical surgery in the winter session. The special subjects and dates will be announced in due course.

PROF. A. H. SAYCE, of Oxford University, has been appointed Gifford Lecturer in Aberdeen University for 1900–1902. The honorary degree of LL.D. has been conferred upon Mr. Charles Stewart, F.R.S., Curator of the Museum of the Royal College of Surgeons, England; and Mr. George F. Stout, Lecturer on Comparative Psychology in Aberdeen University.

AS will be seen from our advertisement columns a successor to the late Prof. Rutherford in the chair of Physiology of the University of Edinburgh will shortly be appointed. Applications for the post, accompanied by relative testimonials, should reach the Secretary to the Curators, at 66, Frederick-street, Edinburgh, on or before May 20.

IN connection with the inauguration of the new buildings of the Middlesex Hospital Medical School, Dr. F. Hetley, a former student, has contributed the sum of 1000*l*. to perpetuate the Hetley Clinical Prize of 25*l*. per annum, founded in 1884.

A CHAIR of Hygiene has been endowed in Harvard University by a donor whose name is withheld.

THE following appointments abroad are announced in *Science*:—Dr. James Monroe Taylor to be president of Brown University; Dr. T. J. J. See to be professor of mathematics at the Naval Academy, Annapolis; Prof. Fritz Regel, of Jena, to be professor of geography at Würzburg; Dr. Erich v. Drygalski, of Berlin, to be professor of geography at Tübingen.

THE resignation of Dr. Robert Otto, professor of chemistry in the Institute of Technology at Braunschweig, is announced.

SCIENTIFIC SERIALS.

American Journal of Science, February.—Contact metamorphism, by J. M. Clements. The various Huronian sediments which form a great portion of the iron-bearing districts of the Upper Peninsula of Michigan have in all of these districts been found to be penetrated by dikes of igneous rocks, which are predominantly basic in character. The author describes the products which have resulted from the intrusion of basic dikes in the Mansfield slate formation. Between the dolerites and the slates there are masses of hard, peculiar hornstone-like rocks, which have a well-banded character. Beginning with the clay-slate, the least metamorphosed rock in the district, the series passes through phyllites, spilosites, and desmosites to those which are known as adinoles, the latter being those which immediately adjoin the intrusive.—The origin of mammals, by H. F. Osborne. The author traces the ancestry of mammals to the Upper Permian, and in doing so he adopts Gill's two subclasses of mammals, namely the *Eutheria*, comprising marsupials and placentals, and the *Prototheria* or monotremes. There are grounds for the view that the *Theriodontia* are the *Hypotheria* or *Promammalia*, because it appears that within the order may well have existed some small insectivorous types, far less specialised in both structures than either the carnivorous Cynodonts or herbivorous Gomphodonts, as one of those conservative species of adaptive radiation which form the focus of a new progressive type.—Chemical composition of tourmaline, by S. L. Penfield and H. W. Foote. The composition was deduced from the results of an analysis of a few specimens carried out with the utmost regard to accuracy. The specimens selected were the colourless tourmaline from De Kalb, St. Lawrence County, New York, and the pale green variety from the felspar quarries at Haddam Neck on the Connecticut River. The authors regard all varieties of tourmaline as salts of the acid $H_9Al_3(B.OH)_2Si_4O_{19}$, in which the complex aluminium-borosilicic acid radicle exerts a mass effect by virtue of which the remaining hydrogens may be replaced by metals of essentially different character without bringing about any pronounced change of crystalline form.—The thermodynamic relations for steam, by G. P. Starkweather. Discusses the application of Van der Waals's equation of condition to steam along the saturation line.—A volumetric method for the estimation of boric acid, by L. C. Jones. This is based upon the reaction $5KI + KIO_3 + 6HCl = 6KCl + 3H_2O + 3I_2$. The liberated iodine may be removed by sodium thiosulphate, and a solution obtained which is absolutely neutral, containing only neutral salts, potassium iodide, iodate, and tetrathionate. Boric acid in moderate amount in solution has not the slightest action on a mixture of iodide and iodate.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 16.—"The Thermal Deformation of the Crystallised Normal Sulphates of Potassium, Rubidium, and Cæsium." By A. E. Tutton, B.Sc. Communicated by Captain Abney, C.B., F.R.S.

In this memoir are communicated the results of sixty-four determinations of the thermal expansion of the orthorhombic crystals of the normal sulphates of potassium, rubidium, and cæsium, carried out for the three axial directions of the crystals with the aid of the compensated interference dilatometer previously described by the author.

The coefficients of cubical expansion exhibit a progression, corresponding to the progression of the atomic weights of the three respective metals. This is true of both the constants a and b in the general expression for the coefficient of cubical expansion, $\alpha = a + 2bt$, for any temperature t.

The order of progression of the two constants is inverted; a, the coefficient for 0°, diminishes with increasing atomic weight of the metal, while b, half the increment of the coefficient *per* degree of temperature, increases. Consequently, the coefficients of cubical expansion of the three salts converge, with rise of temperature, and attain equality in pairs. Beyond the temperature of identity divergence occurs, and an increase of atomic weight is now accompanied by an increase of expansion.

The differences between the coefficients of linear expansion along the three axial directions of any one salt, although only amounting to one-eighth of the total coefficient, are large compared with the differences between the values for the same direction of the three salts. This, together with the fact that the replacement of one metal by another is accompanied by considerable modifications of the relations of two of the three values for the original salt, those corresponding to the axes a and c, prevent the coefficients of linear expansion for any one direction of the three salts from exhibiting any progression corresponding to that of the atomic weights of the three metals.

The increment of the linear coefficient of expansion along the axis c of each salt is about twice as large as the increments for

the other two directions, a and b, for which latter the increments are nearly equal. This is analogous to the optical behaviour.

The amount of expansion along the direction of the axis b is approximately identical for all three sulphates, indicating that interchange of the metals is without influence on the thermal behaviour along this axis.

The chief of the directional perturbations previously referred to consists of a reversal, for temperatures below 50°, of the directions of the maximum and intermediate axes of the thermal ellipsoid for rubidium sulphate, compared with their directions in the potassium and cæsium salts. The maximum thermal axis is c for the two latter salts, but a for rubidium sulphate. A similar reversal of the direction of the maximum axis of the optical ellipsoid (the indicatrix), the first median line, from c to a, occurs for the same temperatures, in the case of rubidium sulphate. The maximum thermal axis is identical with the first median line in all three salts.

At higher temperatures the same relations continue to hold for the potassium and cæsium salts, both thermally and optically. But owing to the increment of expansion along c being so much greater than for the other directions, the intermediate expansion along c for rubidium sulphate attains equality at 50° with the expansion along a, and beyond this temperature c becomes the maximum thermal axis for this salt, as it is for the other two sulphates. Consequently, at 50° the crystals of rubidium sulphate are apparently thermally uniaxial. At temperatures varying 10° each side of 50° for different wave-lengths of light, they have previously been shown to simulate uniaxial optical properties. The thermal and optical ellipsoids of revolution are not, however, identically orientated, the axis of the former being b and of the latter a.

The final conclusion of the investigation, therefore, is that :

The thermal deformation constants of the crystals of the normal sulphates of potassium, rubidium, and cæsium exhibit variations which, in common with the morphological, optical, and other physical properties previously investigated, follow the order of progression of the atomic weights of the alkali metals which the salts contain.

"Observations on the Cerebro-Spinal Fluid in the Human Subject." By St. Clair Thomson, M.D., Leonard Hill, M.B., and W. D. Halliburton, M.D., F.R.S.

One of the authors, Dr. Thomson, has had under his care for some years a very remarkable patient, in whom, without any history of injury, cerebro-spinal fluid dripped continuously from one nostril. Research into the literature of the subject has shown that there are other cases on record which must have been similar, although the true nature of the fluid was not recognised. Some of these patients ultimately died from inflammation of the membranes of the brain, which had probably spread from the nose through the opening in the bony lamina that normally completely separates the cranial and nasal cavities.

The fluid itself is characterised by its clear watery character, its low specific gravity, the small amount of proteid in it, and the absence of albumin, and by the presence in it of a substance which reduces Fehling's solution, but is not dextrose; the substance is possibly related to pyrocatechin. The contrast between such a fluid, and the mucin-containing fluid of ordinary nasal hydrorrhœa is very marked.

Analysis of the fluid which escaped in the evenings showed it to be more watery than that collected first thing in the mornings; the difference is due principally to an alteration in the amount of organic solids. This confirms an observation of Cavazzani on dogs, and is what one would expect, as the decreased capillary pressure during rest would lessen the rate of exudation of water.

The case afforded a unique opportunity to Dr. Leonard Hill to confirm the theories he has advanced concerning the cerebral circulation. He has put forward the view that the rate of secretion of the cerebro-spinal fluid, when the cranio-vertebral cavity is opened, depends directly on the difference between the pressure in the cerebral capillaries and that of the atmosphere. At the same time it was shown that cerebral capillary pressure varies directly and absolutely with vena cava pressure.

On the other hand, cerebral capillary pressure varies directly, but only proportionately, with aortic pressure, for between the aorta and the capillaries there lies the peripheral resistance.

It follows from the above that the easiest methods of raising the cerebral capillary pressure in man are :—

(a) By compression of the abdomen.

(b) By the assumption of the horizontal posture. In this position, however, the rise of venous pressure may be compensated by the fall of arterial pressure, which normally occurs when the body is at rest. This is, no doubt, the case during sleep.

(c) By straining or forced expiratory effort, with the glottis closed.

By all these methods the vena cava pressure is considerably raised; and by the last method the venous inlets into the thorax may be completely blocked, and the pressure in the cerebral capillaries raised to something like aortic pressure.

It is true that by such a forced expiratory effort the aortic pressure is lowered. Nevertheless, the total effect on capillary pressure is a very great rise, for a fall of aortic pressure of 25 mm. of mercury produces a fall in cerebral capillary pressure of less than 5 mm. of mercury, while a rise of vena cava pressure of 25 mm. of mercury produces a rise of cerebral capillary pressure of 25 mm. Hg.

The figures, which are given in detail in the paper, show that in the present case the flow of the cerebro-spinal fluid is accelerated by all the circumstances enumerated, which raise the cerebral capillary pressure. The increase of flow is, moreover, accompanied by a decrease in the percentage of solid matter.

One of the authors (W. D. H.), in conjunction with Dr. Mott, F.R.S., has examined the results of injecting into animals cerebro-spinal fluid removed from cases of brain atrophy, especially from cases of general paralysis of the insane. This fluid contains a toxic substance, choline, doubtless derived from the disintegration of lecithin in the brain. Injection of such fluid into the jugular vein of animals, anæsthetised with ether, causes a marked lowering of arterial blood pressure, which is partly cardiac in origin, but principally due to the local action of the poison on the neuromuscular apparatus of the peripheral vessels, especially in the splanchnic area.

The fluid obtained from the present case was also injected in a similar way. Quantities varying from 7 to 10 c.c. were injected into the circulation in dogs, but with entirely negative results. Such a quantity in the case of fluid from a general paralytic would be quite sufficient to cause a marked fall of arterial pressure.

Mineralogical Society, January 31.—Prof. A. H. Church, F.R.S., President, in the chair.—On a new mode of occurrence of ruby, in North Carolina, by Prof. John W. Judd, F.R.S., and Mr. W. E. Hidden; with crystallographic notes by Dr. J. H. Pratt. About fifteen years ago, very finely-coloured rubies were found at Cowie Creek, North Carolina, and some of these, according to competent experts, have the colour and brilliancy of the finest stones from Burma. These rubies are found in gravels and alluvia underlaid by a "saprolitic" material, the product of the decomposition *in situ* of the rocks of the district. The gems are derived, not like those of Burma from a limestone rock, but from certain basic rocks, such as eclogite, amphibolite, and hornblende schist. Associated with the rubies are found specimens of "rhodolite," a very clear and fine-coloured variety of garnet having a composition intermediate between pyrope and almandine. This garnet is often found enclosed in corundum, so that it must belong to an earlier period of consolidation. In habit, the corundum crystals of Cowie Creek are very similar to those found at Yogo Gulch and other localities where the mineral occurs in rocks of undoubted igneous origin. It is suggested that the rubies of both Burma and Cowie Creek may have originally existed in rocks of basic character of very similar composition.—Experiments on zeolites, by Prof. A. H. Church, F.R.S. The author describes an experiment tending to show that the action of silver nitrate on phillipsite is analogous to that investigated by Eichhorn and by Lemberg in the case of other salts on other zeolites. Prof. Church also exhibited numerous specimens of pure blue apatites from Ceylon, which, owing to their beautiful colour, had been mistaken for sapphires. One of these specimens contained as much as 3·21 per cent. of chlorine, but others only 0·63 per cent. and 0·34 per cent. On the constitution of mineral arsenates and phosphates. II. Pharmacosiderite, by Mr. E. G. J. Hartley. In continuation of his chemical investigation of mineral arsenates and phosphates, the author gives the results of analyses of pharmacosiderite. From 2·4 to 4 per cent. of potash was found in the specimens analysed, and all the Cornish specimens examined contained this alkali. Water determinations made with special care showed that the mineral contains eighteen molecules instead of fifteen, as previously supposed.—The specific identity of binnite with tennantite, by Mr. G. T.

Prior and Mr. L. J. Spencer. Owing to variations in previous analyses, the true character of this rare mineral from the Binnenthal has been hitherto in doubt. The result of the chemical analysis of very carefully selected material, and of the crystallographic examination made by the authors, shows that binnite is identical with tennantite, since neither in its chemical nor in its physical characters can it be distinguished from that mineral.

Linnean Society, February 16.—Dr. A. Günther, F.R.S., President, in the chair.—Mr. Clement Reid exhibited some fruits of *Najas minor*, Allione, and of *Najas graminea*, Delile, found during a further examination of the interglacial deposits at West Wittering in Sussex.—Dr. A. B. Rendle exhibited specimens of a freshwater Alga (*Pithophora*) new to Britain, and described its structure.—Mr. Gilbert C. Bourne read a paper on the genus *Lemnalia*, Gray, with an account of the branching systems of the order *Alcyonacea*. In the course of his remarks some new terms were proposed specially applicable to the morphology of the Alcyonaceans.—Messrs. I. H. Burkill and C. H. Wright read a paper "On some African *Labiatae* with alternate leaves," a peculiarity which had been recently used by M. Hua to characterise a new genus, *Icomum*. To this genus three new species were now added.—Messrs. J. Cosmo Melvill and Robert Standen communicated a "Report on the Marine Mollusca obtained during the first expedition of Prof. A. C. Haddon to the Torres Straits." Over 400 forms of Gastropoda and Pelecypoda were collected, together with a few Polyplacophora. Twenty-four novelties were described, one of the most noteworthy being a Neriteid Mollusc allied on the one hand to *Vanicoro*, and on the other to *Nerita*, for which the generic name *Magadis* was proposed. *Pholadomya Haddoni* was described as a new species.

Zoological Society, February 21.—Prof. G. B. Howes, F.R.S., Vice-President, in the chair.—Mr. A. Smith Woodward read a paper by Dr. F. P. Moreno and himself, on a piece of skin supposed to belong to the *Neomylodon listai* of Ameghino, from a cavern near Consuelo Cove, Lost Hope Inlet, Patagonia. Dr. Moreno's contribution was an amplification of his remarks on the subject made at a previous meeting. He maintained that the specimen in question was of great antiquity, and belonged to the extinct ground-sloth, *Mylodon*. In reply to objections founded on its state of preservation, he supported his contention by mentioning that he had found a well-preserved mummified human body in another cavern in the same district, which certainly belonged to an extinct race of great antiquity, unknown even to the present Tehuelche Indians. Mr. Woodward gave a detailed description of the specimen, pointing out that the skin was unique, even for an Edentate, in having the armour of ossicles confined to the lower half of the dermis, while the covering of hair was implanted in every part of the upper half. He thought he could recognise in it the base of the left ear, and concluded that the piece of skin had probably belonged to the neck. It certainly represented an animal quite as large as *Mylodon*; but he noted discrepancies in the microscopical structure of the dermal ossicles, which inclined him to believe in its generic distinctness. The problem could not be solved, because the dermal armour of *Mylodon* had only been definitely described in the lumbar region, and it was quite possible that the ossicles in the flexible neck of the animal might not agree with those in the comparatively rigid back above the pelvis. If Dr. Moreno had not been able to give so circumstantial an account of the discovery, Mr. Woodward would have unhesitatingly pronounced the skin to belong to a recent animal killed quite lately.—A communication was read from P. W. Bassett-Smith, R.N., containing observations on the formation of the coral-reefs on the N.W. coast of Australia. Special attention was called to the part played by massive *Polyzoa* in forming coral-reefs.—A communication was read from Mr. G. A. Boulenger, F.R.S., containing an account of a collection of reptiles and batrachians made by Mr. J. D. La Touche in N.W. Fokien, China. Eight species were described as new to science in the present paper, amongst which was a snake belonging to a new genus, most nearly allied to *Opisthotropis* of Günther, proposed to be called *Tapinophis latouchii*, after its discoverer.—A communication was read from Sir G. F. Hampson, Bart., containing the second portion of his "Revision of the Moths of the subfamily *Pyraustinae* of the family *Pyralidae*."

Anthropological Institute, February 14.—Mr. C. H. Read, President, in the chair.—A paper was read by Colonel Sir T. H. Holdich, K.C.I.E., C.B., on "The Arab Tribes of our India Frontier." After describing the physical features of the country, the author proceeded to discuss certain ethnological questions. Many of the existing tribes can be identified with those named by Herodotus and Strabo. The author gave a sketch of Arab influence in Baluchistan, which was, he suggested, greater than is commonly supposed. The explanation why our control of the southern borderland is more effective than it is in the north, is that in the former we are not merely facing the Baluch tribes, but we are at the back of them. Besides this, the Baluchis have a well-defined tribal organisation, and the dealings of the Indian Government with them are thereby much facilitated The author's view as to the predominance of Arab influence in Baluchistan was disputed by Messrs. J. Kennedy and W. Crooke.

MANCHESTER.

Literary and Philosophical Society, February 7.—Mr. J. Cosmo Melvill, President, in the chair.—Notes on the slipperiness of ice, by Prof. Osborne Reynolds, F.R.S. The author referred to some experiments by Mr. Beauchamp Tower on the lubrication of two metallic surfaces, and showed the extraordinary degree of coherence between two "Whitworth planes" after they had been pressed together so as to squeeze out the film of air between. All lubrication is due to the presence of a fluid, either liquid or gaseous, between the opposing surfaces, and in the case of ice the pressure induces a partial liquefaction, which is the sole cause of slipperiness. When ice is cooled below a certain point, it becomes no more slippery than a polished surface of stone.—On science in the "Historical English Dictionary," by C. L. Barnes. It was pointed out that "astronomy" and "astrology" have interchanged meanings since they were first introduced, as is clearly shown by Evelyn in his "Memoirs" (1676), where he says: "Dined with me Mr. Flamsteed, the learned astrologer and mathematician, whom his Majesty had established in the new observatory in Greenwich Park." The science of chemistry appears to have been unhappy in its first introduction into literature, for Gaule (1652) speaks of it as "a kind of praestigious, cheating, covetous magick," and Bentham, in 1812, makes use of this language: "Idioscopic, or cryptodynamic anthropurgics has for its single-worded synonym the unexpressive appellation chemistry." The curious derivation of "alcohol," from the Arabian "kohl," referred to in 2 Kings, ix. 30, and in Ezek. xxiii. 40, as a material for personal adornment, was next referred to. From meaning a fine powder, produced either by trituration or sublimation, the latter sense gradually slid off towards distillation, though in Spanish the words alcohol, alcoholado, alcoholador, and alcoholar still retain their ancient significance in part. The derivation of the word "antimony" itself, and Littre's conjecture that the same Arabic root has furnished both "antimonium" and "stibium"—the latter through the Greek "stimmi"—was also noticed. Under the heading "Atom," the Dictionary quotes, besides the ordinary meanings, a table of Papias, Bishop of Hierapolis in Phrygia in the second century, in which the word signifies a small interval of time, the 22,560th part of an hour. A similar usage is found in the Greek text of 1 Cor. xv. 52, where the expressions "en atomo, en rhipe ophthalmou" are translated "in a moment, in the twinkling of an eye." But most important of all is the discovery, announced alone in this dictionary, that the word "gas" was suggested to Van Helmont by the Greek "chaos," or, as he himself puts it: "Halitum illum 'gas' vocavi, non longe a chao veterum secretum." The spirant sound of the Dutch "g" was probably taken as a nearer equivalent of the Greek "ch" than "k" would have been. Lastly, allusion was made to the originally divergent meanings of "algebra," as a branch of mathematics and the art of bone-setting, which are still both in use in Spain.

PARIS.

Academy of Sciences, February 27.—M. van Tieghem in the chair.—The Perpetual Secretary announced the death of M. Sophus Lie, Correspondant of the Section of Geometry.—Notice on M. Sophus Lie, by M. Darboux.—An electrolytic interruptor, by M. d'Arsonval. A description of Wehnelt's electrolytic interruptor.—On a new uranium mineral, carnotite,

by MM. C. Friedel and E. Cumenge. The mineral occurs mixed with silica in a finely divided state at Montrose, Colorado. It dissolves readily in nitric acid, and contains uranium, vanadic acid, and potassium, together with traces of iron, alumina, copper, lead and barium. The composition was found to be $2U_2O_3.V_2O_3.K_2O.3H_2O$.—On some new and important applications of photography made in Canada in the production of plans, by M. A. Laussedat.—An attempt at a new form of the characteristic equation of fluids, by M. E. H. Amagat. A somewhat complex formula containing ten constants is given as a closer approximation to the behaviour of carbon dioxide than the usual $pv = RT$ equation.—Prof. Ray Lankester was elected a Correspondant for the Section of Anatomy and Zoology, in the place of the late M. Lovén.—M. Lortet was also elected a Correspondant for the same section, in the place of the late M. Steenstrup.—On linear partial differential equations, by M. E. Vessiot.—Transformation of the X-rays by different bodies, by M. G. Sagnac.—Influence of very low temperatures on phosphorescence, by MM. Auguste and Louis Lumière.—The amplification of sounds in phonographs, by M. Dussaud. The intensity of the sound emitted by the phonograph increases with the diameter of the registering cylinder.—On the relation which exists between the molecular weights and densities of fluids, by M. Daniel Berthelot.—On the phosphorescence of strontium sulphide, by M. J. R. Mourelo.—On ethene-pyrocatechol, by M. Ch. Moureu.—Method of analysis of acetone oils, and their composition, by MM. A. and P. Buisine. The acetone oils obtained from wool contain about 75 per cent. of ethyl-methylketone, and less than 5 per cent. of acetone.—On the combinations of phenyl hydrazine with alcoholic iodides, by MM. P. Genvresse and P. Bourcet.—On the direct transformation of ammonia into nitric acid in liquid media, by M. E. Demoussy.—On the fermentation of galactose, by M. Dienert.—On the source of the fossilised shells of ostracods which fell at Oullins, near Lyons, on September 24, 1898, by M. R. Fourtau. The author concludes that the shells could not have come from Egypt.

DIARY OF SOCIETIES.

THURSDAY, MARCH 9.

ROYAL SOCIETY, at 4.30.—A Preliminary Note upon certain Organisms isolated from Cancer, and their Pathogenic Effects upon Animals: H. G. Plimmer.—On the Gastric Gland of Mollusca and Decapod Crustacea; its Structure and Functions: Dr. MacMunn.—On the Structure and Affinities of *Matonia pectinata*, R.Br., with Notes on the Geological History of the Matonineæ: A. C. Seward, F.R.S.—A Sugar Bacterium: Prof. H. Marshall Ward, F.R.S. and Prof. J. R. Green, F.R.S.—Note on a New Form of Light Plane Mirrors: A. Mallock.

SOCIETY OF ARTS (Indian Section), at 4.30.—Leprosy in India: H. A. Acworth.

MATHEMATICAL SOCIETY, at 8.—Note on a Property of Groups of Prime Degree: Prof. Burnside, F.R.S.—Note on the Expansion of $\tan(\sin\theta) - \sin(\tan\theta)$ in Powers of θ: R. H. Pinkerton.—Remarks on the Phenomenon of Zeeman and its Bearing on the Problem of the Origin of Spectra: Dr. J. Larmor, F.R.S.—Note on Involution: G. B. Mathews, F.R.S.—The General Conic and its Normic Equations: Prof. A. Sawin.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Subject announced at Meeting of March 2.

FRIDAY, MARCH 10.

ROYAL INSTITUTION, at 9.—Measuring Extreme Temperatures: Prof. H. L. Callendar, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.—(1) Occultations observed during the Lunar Eclipse of 1898 December 27; (2) Nebulæ observed during the Year 1898: Cape Observatory.—On the Use of the Electric Light for the Artificial Star of a Zöllner Photometer: W. de Sitter.—The Radiant Point of the April Meteors (Lyrids): W. F. Denning.—Observations of Hind's Variable Nebula in Taurus: E. E. Barnard.—Determination of the Diameter and Compression of the Planet Mars: Prof. W. Schur.—Periodic Variation in the Colours of the Equatorial Belts of Jupiter: A. Stanley Williams.—Double-Star Observations, 1895–98: W. H. Maw.—*Papers promised*: (1) Note on the Diurnal Variations of the Nadir and Level of the Greenwich Transit Circle; (2) The Greenwich Meridian Observations of Polaris, 1836–93, with Reference to Personality, the Constant of Aberration, and the Star's Parallax: Royal Observatory, Greenwich.

PHYSICAL SOCIETY, at 5.—(1) A Study of an Apparatus for the Determination of the Rate of Diffusion of Solids dissolved in Liquids; (2) Note on the Source of Energy in Diffusive Convection: Albert Griffiths.—An Exhibition of Dr. A. Wehnelt's Electrolytic Current Interruptor for Ruhmkorff Coils: A. A. Campbell Swinton.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Construction of the Elan Aqueduct, Birmingham Waterworks: H. Lapworth.

MALACOLOGICAL SOCIETY, at 8.—On an Apparently Undescribed *Ariophanata* from Mysore, with a Note on *Mariaella dussumieri*: W. T. Blanford.—Description of a New Species of *Hemiplecta* from Perak: Edgar A. Smith.—On a New Species of *Dinoplax* and *Chiton* from South Africa: E. R. Sykes.—Description of Five New Species of New Zealand Land Mollusca: H. Suter.

SATURDAY, MARCH 11.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S.

MONDAY, MARCH 13.

SOCIETY OF ARTS, at 8.—Cycle Construction and Design: Archibald Sharp.

ROYAL GEOGRAPHICAL SOCIETY (at the University of London, Burlington Gardens, W.), at 8.30.—The Uses of Practical Geography, as Illustrated in Recent Frontier Operations: Colonel Sir T. H. Holdich, K.C.I.E., C.B., R.E.

TUESDAY, MARCH 14.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

ANTHROPOLOGICAL INSTITUTE, at 8.—Secret Tribal Societies of West Africa: H. P. FitzGerald Marriott.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Papers to be discussed: Water-Tube Boilers for Marine Engines: J. T. Milton.—Recent Trials of the Machinery of War-Ships: Sir. A. J. Durston, K.C.B., R.N., and H. J. Oram, R.N.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Theoretical Considerations in choosing Colours for Three-Colour Printing: Captain W. de W. Abney, C.B., F.R.S.

WEDNESDAY, MARCH 15.

SOCIETY OF ARTS, at 8.—Liquid Fuel: Sir Marcus Samuel.

ROYAL MICROSCOPICAL SOCIETY, at 8.—The Projection Microscope: Lewis Wright.

THURSDAY, MARCH 16.

ROYAL SOCIETY, at 4.30.—The Croonian Lecture: On the Relation of Motion in Animals and Plants to the Electrical Phenomena which are associated with it: Prof. J. Burdon Sanderson, F.R.S.

LINNEAN SOCIETY, at 8.—So-called Quintocubitalism in the Wing of Birds: P. Chalmers-Mitchell.—Some Facts concerning the so-called Aquintocubitalism of the Bird's Wing: W. P. Pycraft.—A Further Contribution to the Freshwater Algæ of the West Indies: W. West and G. S. West.

CHEMICAL SOCIETY, at 8.—Influence of Substitution on Specific Rotation in the Bornylamine Series: Dr. M. O. Forster.—Rotatory Power of Optically Active Methoxy- and Ethoxy-propionic Acids prepared from Active Lactic Acid: Prof. Thomas Purdie, F.R.S., and James C. Irvine.

FRIDAY, MARCH 17.

ROYAL INSTITUTION, at 9.—The Electric Fish of the Nile: Prof. F. Gotch, F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Backwater or Hæmoglobinuric Fever: Dr. W. H. Crosse.

SATURDAY, MARCH 18.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S.

CONTENTS.

THURSDAY, MARCH 16, 1899.

THE FRILLED FRINGE OF THE SOUTH COAST.

The Geology of the Isle of Purbeck and Weymouth. By A. Strahan. Pp. xi + 278. (London: Printed for her Majesty's Stationery Office, by Wyman and Sons, Ltd., 1898.)

ANYONE travelling from London to the South Coast may see how the gentle southerly inclination of the chalk, which has carried it under the Tertiary beds, changes on the south side of the trough, bringing the chalk up again with a steeper slope, but now with a northerly dip; how it then folds over the axis of the Wealden anticlinal, only to fall to the south more rapidly than it did before, and pass under the waters of the Channel. If we make our traverse further west, there, in consequence of the strike of the rocks being oblique to the trend of the coast, we find still more southerly folds brought into view, and the chalk, after passing rapidly under the Tertiary beds of the Hampshire basin, reappearing in the Isle of Wight, with the strata vertical or even thrown over beyond the vertical. Along this line of disturbance older and older Mesozoic rocks turn up in the anticlinal folds.

Here, as in many other parts of the world, we have plications increasing in sharpness as we cross the strike towards some axis of principal intensity. As might be expected, these folds and their accompanying disruptions, being of the nature of local readjustments in an area of long-continued crush, are seen to be of different dates. When we carry our investigations further afield we find that the disturbances of the strata, which in this district are shown to be modern and probably still going on, belong to a very ancient system of strains, for the Palæozoic rocks of Belgium, Dover and Somerset are still more severely contorted, and the Mesozoic formationsi rest almost undisturbed on the upturned and eroded edges of these older previously folded beds.

The author of the work before us has found himself called upon to describe and explain the structures and sequence of rocks occurring in one of the most interesting of these crumpled coast districts. His reputation as one of the soundest of the younger school of geologists, as well as the names of those of his colleagues who have contributed to the work, are a sufficient guarantee that it is an important addition to scientific literature.

The public hardly realises what an immense amount of valuable scientific work is contained in the maps and memoirs of the Geological Survey, and the accuracy of even the older Survey work is marvellous if we take into account how much of it may be considered as the efforts of pioneers, carried out when comparatively little was known of the methods of discrimination and the data for classification which are now available.

A work of such importance as this by authors of such position in science as those who have contributed to it would have been very differently turned out by the far-sighted American Government, by artistic Italy, or spirited little Portugal. To spend so much on a scientific staff, and then depreciate the results in the face of the world by issuing them in the unattractive form in which our Survey Memoirs are published, is not business-like, to say the least of it. That the present volume is above the average is clearly due to careful drawing and revision by the author rather than to an improvement in the system, which we see in the relegation of the valuable *résumé* by the Director-General to such small print as would seem to indicate as clearly as if it were printed at the head, "Preface, of no importance, pass on to the next," or which gives in some of the sections a lot of small blots and blobs, often unreadable with a lens, to represent the numerals referred to in the text; while the ink, which is superfluous here, might have improved the capitals elsewhere.

The work is a treatise upon the geology of a defined area, and to give an account of this would be to make an abstract of a book already too much condensed. The formations included range from the Fullers' Earth to Recent, but the greater part is devoted to the Jurassic and Cretaceous Series; the Tertiary and Recent beds do not occupy many pages. The rocks are much disturbed, and an interesting account is given of the character and age of the earth movements which have affected them. No molten matter has burst through these broken strata. The crush has been in some cases so severe that the flints have been reduced to powder, and drawn out into black streaks like so much coal dust (p. 179), while large masses of rock have been thrust forward, the older being often pushed over the newer in vast slices, and portions pinched out so that the thickness has been reduced to one-fourth of what it was. The structure of the district is complicated by crossing systems of folds which produce oval or spoon-shaped basins and domes, varying according to the relative intensity of either system. As these are arranged in quincunx pattern they frequently come into view *en échelon*. The classification and nomenclature have demanded the consideration of some theoretical questions of scientific importance; and here especially we have to thank the officers of the Survey for using words which convey a clear idea to the public of what they are talking about, instead of endeavouring to show their own ingenuity, wide reading or knowledge of foreign languages in the invention or adoption of new and unnecessary terms.

If there is a doubt as to the horizon at which the boundary between the Jurassic and Cretaceous systems should be drawn—and a suspicion arises that the equivalent position has not been assigned to it in different areas—we must inquire whether this difficulty arises from wrong identifications among the stratified rocks in either of the localities, or whether there has not been some change of conditions which has made it difficult to prove exact chronological identity between the series seen in the several more or less widely separated areas. For instance, land surfaces are suffering denudation, while sediment is being deposited in an adjoining area in sea or estuary or lake or river. In the district described there are several successive deposits which have a tendency to become coarser as we follow them westward, or point to the local incoming of estuarine or fluviatile conditions. In such an unstable area palæontological continuity or interruption will depend upon slight geographical changes.

Whether an estuary existed in the Weald while beds which have been shown to belong to conditions continuous with those of later Jurassic times were being laid down elsewhere, or whether that estuary did not exist until the movement which resulted in the deposition of the Cretaceous series had fairly set in, is a very pretty subject for inquiry; but the relations of the rocks inferred from sections seen in any district must be fairly stated without any forced hypotheses, adopted in order to accommodate the evidence to inferences drawn from sections in other parts of the country, and it is very difficult to avoid the suspicion that the Lower Greensand of East Anglia, which is the obvious basement bed of the Cretaceous of that area, may not be the equivalent of only the uppermost part of what has been called Lower Greensand further south.

In trying to find a satisfactory explanation of some of the superficial deposits, our author is driven to invoking that *deus ex machina* the frost of the Glacial Epoch (p. 199); but we may let the curtain fall on that.

The Chesil Bank is described in some detail. What with the wear and tear of the pebbles, and the cutting-off of the supply, it would appear that the foot shows an annual balance against the bank, so that some day it must break.

Many questions of economic geology are treated of throughout the work, and a short *résumé* of them is collected into a separate chapter. Among them that of water supply is not the least important. We learn how water that is banked up by other and impure water may be itself quite safe if not too heavily drawn on; but if the pure water be exhausted the surrounding impure water will be sucked into the well, as was done at Portland, where the sea-water which had held up the fresh inland water was eventually drawn into the well by heavy pumping (p. 119).

Many products of commercial value occur in the rocks of the district. Portland stone is used all over the country for building, and is locally burnt for lime. The Purbeck limestone is found in the fine fluted shafts of every church of the thirteenth century which had any pretension to architectural beauty, and has been in great demand for decorative purposes ever since. It has recently been employed in the church at Arundel. The Kimmeridge coal, derived perhaps more from animal than from vegetable matter, is used only by those whose poverty forces them to endure its almost intolerable smell. The brown hæmatite (p. 37-40) is of more scientific than practical importance.

We could hardly recommend the student of geology a more useful vacation course than to take a trustworthy guide of this kind to a limited area, and with it to examine the stratigraphy of the district, especially following and copying the admirable sections given at the end; to trace the boundaries of formations, and then compare his lines with those on the index map given on Plate viii., or, better still, with the Survey maps on a larger scale; to learn, by the help of the figures of peculiar or numerically predominant fossils, to discriminate species, and by them the zones of life; and, when he again finds himself within reach of books, to follow up the special points of difficulty or doubt by hunting up the references so clearly arranged in the appendix, as well as given in the foot-notes. He may thus obtain a very good conspectus of the Jurassic and Cretaceous rocks from the Fullers' Earth up, and an insight into many of the more complicated effects of earth movements and super-induced structures; for the author has wisely treated in a separate chapter of the evidence for the existence, extent, and character of the several disturbances which have to be invoked to account for the relative position of the rocks of the district. Here among recognisable fossiliferous deposits we may trace and study the nature of the great movements resulting in folds, faults, and overthrusts, which are of the same kind as those inferred to exist among the older rocks of Scotland and the Alps, where identification is often less easy.

Any intelligent resident in the district who cares to know the meaning of what he sees around him should possess a copy. In it he may read how the geological structure has determined the character of the scenery (Introduction, pp. 51, 133, &c.), and the interesting analogy between the physical geography of the basins of the Frome and the Thames. He will find an explanation of that pretty hollow known as Poxwell's Circus (p. 69), of the subterranean fires that burned so long in the cliffs of Kimmeridge (p. 57), or of the mode of formation of the travertine, reminding us of the deposition of Geyserite in Yellowstone Park by the aid of a confervoid alga.

If he is an archæologist he will turn with interest to the speculations as to the geological changes supposed to have taken place in Neolithic times, and the gravels deposited in the Palæolithic Age (pp. 234, 235). The Lynchets (p. 97) will remind him of the Raines of the North of England, which have a similar origin, and the account of the Sarsen stones (p. 196), so largely used by the builders of Cromlechs and Stone circles, will open up a wide field for speculation. Or he may turn to a question of more specially local character, and, in the chapter on the Kimmeridge clay, find an explanation of the so-called coal-money, and an account of the cups or vases made from Kimmeridge coal which have been found in barrows, and associated with Roman remains (p. 53).

An old submerged forest is always an object of great interest, and perhaps more suggestive of the changes that time has brought about than any other geological feature. But here along the shore between Bacon Hole and Lulworth Cove we may see a forest of Jurassic age, with numerous trunks and stools of trees belonging to a time when all life was different from that of to-day (p. 102). The landslips of the Isle of Portland (p. 112) tell of another kind of change spasmodically incessant and producing great results.

This is, therefore, a book of wide interest, extending far beyond the limited area which it describes.

PHYSICAL CHEMISTRY.

Leçons de Chimie Physique. Par J. H. van 't Hoff. Ouvrage traduit de l'allemand par M. Corvisy. Pp. 263. (Paris: Hermann, 1898.)

THIS book is a translation of van 't Hoff's "Vorlesungen über theoretische und physikalische Chemie," based on lectures delivered in the University of Berlin during the winter session 1896–97, and as a

ear and terse exposition of the principles of physical chemistry cannot be too highly commended. The treatment of the subject adopted by the author presupposes a considerable knowledge of chemistry and physics, as well as an elementary acquaintance with the differential and integral calculus. The first instalment, here under review, is entitled "Chemical Dynamics," and will be followed by other parts dealing with chemical statics, and the relation between properties and chemical composition. The distinction made by the author between chemical dynamics and chemical statics is similar to that adopted by Lothar Meyer. Under chemical statics he proposes to deal with theories of the structure of matter, the conceptions of atom and molecule, and the determination of constitution and configuration. Under chemical dynamics he here discusses chemical change, affinity, velocity of reaction, and chemical equilibrium.

Beginning with chemical equilibrium, he treats the subject first from the thermodynamical standpoint, and then from the standpoint of the kinetic molecular theory. This dual mode of treatment has many advantages. The student is introduced to the study of chemical equilibrium without being concerned with any hypothesis regarding the inner mechanism of the systems considered. He is only occupied with the different phases (or mechanically separable components) involved, and gains the necessary insight into the subject through diagrams of volume, pressure, temperature and concentration, together with some simple deductions from the fundamental principles of thermodynamics. Transformation points, vapour pressure, dissociation pressure of solids, and solubility naturally have their place here, equilibrium for one and two substances being treated at length. Examples are also given of cases of equilibrium with three and four substances; but owing to the multiplicity of phases, the diagrams are necessarily complex and rather cumbrous. Dissociation, both gaseous and electrolytic, etherification, equilibrium between electrolytes, hydrolysis, and the avidity of acids and bases are more conveniently dealt with from the molecular standpoint; and the section concludes with general considerations as to the effect of pressure and temperature on chemical equilibrium.

The velocity of chemical action is naturally also treated from the kinetic point of view, and first the author gives a theoretical discussion of the subject, exhibiting the nature of uni-, bi-, and trimolecular reactions, the relation of velocity constants to equilibrium constants, the method for determining the number of molecules taking part in a chemical action, and the nature of the retarding influences at work. Then follows a selection of representative empirical results regarding the influence of the medium, temperature, and pressure on the reaction velocity. Finally, an account is given of the progress of the reaction wave, and in particular of the explosion wave.

The translation is well done, and will probably appeal more to English readers than the original. One or two slips which appear in the German edition might have been corrected in the French version; *e.g.* in the pressure-temperature diagram of sulphur, Fig. 9, the line KF should slope upwards and away from the pressure axis instead of towards it, and at p. 66, line 10, *tension* should obviously be *température*. J. W.

THE CULTIVATION OF BERRIES.

Bush Fruits. By Fred. W. Card. Pp. xii + 537; 113 illustrations. (New York: the Macmillan Company. London: Macmillan and Co., Ltd., 1898.)

THIS is in more senses than one a remarkable book. The title-page tells us that it is a "Horticultural monograph of raspberries, blackberries, dewberries, currants and other shrub like-fruits" (*sic*). The preface tells us that the book "is an extension of a thesis presented to the Cornell University for the degree of Master in Science in Agriculture." It is hard to imagine any university in this country recognising a thesis on the art of growing gooseberries and currants! Yet that the subject is capable of scientific treatment is evidenced by the volume before us. The aim is "to treat general truths and principles rather than mere details of practice. A book cannot instruct in all the details of any rural business because these details vary with the environment and personality of the operator. The book should attempt, therefore, to give such instruction as to enable the reader to think out and to solve the local problems for himself."

The first part is devoted to general considerations concerning the situation and management of a fruit plantation. In the second part the brambles, raspberries, blackberries, and similar fruits are considered in detail, and in a manner utterly different from what we should expect in a graduation thesis.

Part iii. is similarly devoted to "Groselles," a word invented by the author to include both gooseberries and currants. Here we find the same minuteness of detail and accumulation of facts as in the other portions of the volume.

The fruits enumerated are mostly of American origin and of recent development, and they illustrate in a very striking way the enormous strides which our American cousins are making in all matters relating to the cultivation, the packing, "canning" and marketing of fruits. They show a fertility of invention, a readiness to adopt new procedures, and to avail themselves of opportunities to a degree which we look in vain for on this side of the Atlantic. In the matter of climatal conditions the United States have, so far as these particular fruits are concerned, no advantage over the mother country. Already we have American cranberries exposed for sale in every grocer's shop in the kingdom, whilst we do not suppose that the whole available area in Ireland, Wales or Scotland sends to market a week's supply.

A curious circumstance to be noted about the fruits which form the staple of this volume is that they are mostly of American origin. British gooseberries or European currants do not, as a rule, thrive in the States, or, rather, they cannot so well resist the attacks of the mildews and moulds as the bushes of native origin do, and consequently the English varieties go out of cultivation as less fitted to the environment than the native varieties.

Another point to be noted is the comparatively recent origin of these varieties. Our gooseberries and currants represent the selection that has been going on here for ages, and as we rarely if ever see any advance in these fruits nowadays, but only a kaleidoscopic shifting of old

materials, it may be that we have attained the limits of variation in this direction, and that to get something new and better we must break new ground by hybridisation or cross-breeding.

Illustrations are given in the volume before us of numerous insects and fungi which make themselves obnoxious to the fruit-grower. Some of these are the same that are too well known to us; but whether or no, the general principles of prevention or destruction are the same. We know of no work containing anything like so complete an account of these "bush fruit," and although it is mainly serviceable to American cultivators, it will also prove a veritable encyclopædia to British growers.

OUR BOOK SHELF.

L'industrie du Goudron de Houille. By George F. Jaubert. Pp. 172. (Paris: Gauthier-Villars et Fils, 1899.)

In this book, which belongs to the "Encyclopédie scientifique des Aide-Mémoire," is given a brief account of the numerous chemical substances directly derived from coal-tar. The introduction contains a short historical account of the rise of the coal-tar industry, and this is followed by a very brief description of the methods of separation adopted for light and heavy oils, phenols, and ammonia liquor; a section being specially devoted to the nature and yield of tar formed in the preparation of coke in Carvès ovens for metallurgical operations. The actual processes used for the separations of hydrocarbons and ammonia are very briefly sketched, no diagrams whatever being given. The remaining three-fourths of the book consists of a methodical description of the properties of each of the various chemical substances the presence of which has been recognised in coal-tar or coal-gas; this description, as a rule, being unaccompanied by any account of the methods by which the particular constituent under examination has been isolated from the tar. It is, in fact, a miniature chemical dictionary with a systematic instead of an alphabetic classification. The short bibliography at the end of the book will doubtless be of some use to students.

Grundriss einer Geschichte der Naturwissenschaften. By Dr. Friedrich Dannemann. Vol. II. *Die Entwicklung der Naturwissenschaften.* Pp. 435. (Leipzig: W. Engelmann. London: Williams and Norgate, 1898.)

The first volume of this work was noticed in Nature in 1896 (vol. liv. p. 316). It consisted of extracts and translations from the writings of great philosophers and investigators, and presented an attractive panorama of scientific history. The second volume has not been constructed upon the same plan, but consists of a descriptive statement of researches and discoveries which have contributed to the progress of science. Many original illustrations have been reproduced, and numerous references are given to papers which have helped to make scientific history. The volume is an interesting "entwicklungsgeschichte," and it presents the early stages in sufficient detail; but it cannot be regarded as a satisfactory statement of the modern developments of science.

Dr. Dannemann divides the history into four periods, each of which is dealt with in a separate section of the book. The first part contains a survey of the views and works of the early Greek philosophers, up to the destruction of the Alexandrian library in 642 A.D.; the second part is concerned with the period from 642 A.D. to about the end of the fifteenth century; the third period considered extends from the time of Copernicus to the end of the eighteenth century, and includes the epochs of the foundation of modern chemistry and the discovery of the galvanic battery; and, finally, the period—"Die neueste Zeit"—continues the history to the present epoch.

It would, of course, be impossible to give anything approaching a complete account of scientific work from the early Greek philosophers to the present time in a volume of the dimensions of the one before us, and Dr. Dannemann has not attempted to do so. His volume presents a view of the investigations which laid the foundations of modern science, but it does not go further.

The work is an interesting contribution to the literature dealing with the development of the study of nature in many aspects, and as such is an inspiring volume for students of science. Perhaps the author will produce a third volume in which the advances made during this century will be described.

Practical Work in Physics. Part iv. Magnetism and Electricity. By W. G. Woollcombe, M.A. (Oxon), B.Sc. (Lond). Pp. xi + 112. (Oxford: Clarendon Press, 1899.)

This little volume completes Mr. Woollcombe's course of practical physics for use in schools and colleges. It is a little difficult to understand why no experiments in statical electricity are included, for some of these are valuable in accentuating principles of great importance to a student of this branch of physics. The pupil into whose hands the instructions here set down are put, must already have some theoretical knowledge of the subjects dealt with, or little benefit is likely to accrue from the performance of the experiments. It is hardly a beginner's book, for, in addition to the necessity for a modicum of preliminary acquaintance with principles, familiarity with trigonometrical ratios is taken for granted. At the same time, for the higher classes of schools of the order in which the author himself teaches, the experiments described are very suitable.

Ostwald's Klassiker der exakten Wissenschaften, Nos. 97–102. (Leipzig: Wilhelm Engelmann. London: Williams and Norgate, 1898.)

The following additions to Prof. Ostwald's comprehensive series of annotated reprints and translations of scientific classics have lately been published.

No. 97 (pp. 156) contains a translation, with facsimile illustrations, of Newton's second and third books on optics, dealing with the reflection, refraction, and colour of light, and the theory of the rainbow. The papers have been translated and edited by W. Abendroth.

No. 98 (pp. 39) is a paper "Ueber das Benzin und die Verbindungen desselben," by Eilhard Mitscherlich (1839), edited by J. Wislicenus.

Clausius's paper "Ueber die bewegende Kraft der Wärme" (1850), forms No. 99 (pp. 55), and will be of interest to all students of thermodynamics. It is edited by Dr. Max Planck. Dr. Planck also edits Kirchhoff's papers on emission and absorption of light and heat (1859–1862), printed in No. 100 (pp. 41), and the papers read in 1858 on the mechanical theory of heat, printed in No. 101 (pp. 48). The former reprint contains a portrait of Kirchhoff as a frontispiece.

A translation of Clerk Maxwell's papers on lines of force (1861–2) appears in No. 102; and to the eighty-four pages, which they occupy, Prof. Boltzmann adds sixty-two pages of notes.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Colour of Sea Water.

AITKEN (*Proc. R. S. E.*, vol. ii. p. 472, 1882) has given a complete theory of the colour of sea water as observed at various places, based upon the principle that sea water is a blue liquid. According to this view, the green tint often observed in sea water, especially near land, is to be explained by the presence of fine yellow particles. During a recent voyage by the Messageries steamer *Polynesien*, I was permitted, through the kindness of Commandant Bullard, to erect a tube 736 cm. long against the rail of the after-deck, and to pass through it a continuous stream of water from the ship's salt water service. The water was taken in well forward and at a depth of two or three metres, and consequently was not soiled by the passage of the ship. I made a series of observations with the apparatus described, matching the colour of the sea water by making mixtures of definite substances, and using these mixtures to fill a tube 18 cm. long, placed alongside the water tube. Both tubes were illuminated by diffused daylight reflected from a white screen, and by the aid of diaphragms, &c., it was arranged so that the angular area of the visible part of the screen was the same whether observed through one tube or the other. Observations were made every day on the voyage from Sydney to Marseilles; but, owing to the uncertainty arising from the contamination of the water by the varnish with which the interior of the tube was protected, it is useless to comment on most of the results obtained, except in so far as they give a means of easily reproducing the exact tint of pure sea water as seen through a column 736 cm. long. Make up the following solution:—

Water, 500 c.c.
Soluble prussian blue, ·001 gram.
Saturated lime-water just precipitated by the smallest excess of bicarbonate of soda, 5 c.c.

This mixture, when viewed through a tube 18 cm. long, will show with considerable precision the colour of a sample of water from the Mediterranean, lat. 36° 24′ N., long. 17° 51′ E. of Paris.

By using various lengths of tubes I found that when a match has once been made, it can be preserved (within the limits tested) by increasing the amount of prussian blue proportionally to the length of the column of water under investigation. In these tests I made use of tubes 183 cm. long, which could be mounted in series; the relation held as the number of tubes was increased from two to five.

I consider that it would be worth while for a series of measurements to be made systematically by this method, and therefore mention that the tubes must be of black porcelain or glass; the water must be pumped by the observer's private pump (which must be worked off the electric service), and must give a pressure large enough for a Berkefeld filter. The colour of daylight is also too variable on the deck of a ship protected by awnings, and a form of artificial illumination should be employed. In making the colour matches, it is best to arrange to look down the two tubes simultaneously, using one eye for each tube. By slight squinting, it is easy to get the sensation of two patches of colour on the screen seen side by side.

The majority of the samples of water examined by me took 25 per cent. less blue to match them than the example quoted; and when the water was soiled by the tube, and perhaps at other times, it was necessary to add an amount of picric acid rising to a large proportion of the prussian blue, and, of course, giving a green solution. The transparency of the water is estimated by the amount of precipitated chalk it is necessary to add. At the same time, I am not sure that the loss of light observed, and requiring this addition to the match, is produced by turbidity. It is just as likely that the absorption spectrum of water is crossed by a faint but uniform band from end to end. In this case a black liquid might be added to make the match, but I do not know of one which is anything like black in very dilute solution; of definite materials the best was the aniline dye sold under the name of steel-grey, but it was very distinctly purple.

The water on the west and south-west coast of Western Australia is perhaps more interesting than any I have seen, for it is very green indeed, and very clear: so much so as to raise a doubt of the adequacy of Aitken's explanation, especially as the sand looks white rather than yellow. It is just possible that the sea may in certain places dissolve a sufficiency of yellow colouring matter from living or dead sea-weed to account for the green tint.

All the observations I made convinced me that the possible scattering of light by very fine particles in suspension has got nothing to do with the colour of the sea water.

RICHARD THRELFALL.

45 Frederick Road, Edgbaston, March 4.

Another Stockton Dragon.

SINCE we chronicled in NATURE in September last the find of an Ichthyosaurus in Mr. Lakin's pit at Stockton, the men in the neighbouring quarries have thirsted for the renown which a similar discovery would bring. Great care has been employed with the pick as each succeeding layer of clay was reached, and more than one false alarm has been raised. Last week a specimen less complete, but still remarkable, was unearthed in the cement works belonging to Messrs. Kay and Co. It lies 50

feet below the surface. The head is tolerably perfect, showing the teeth and one of the eyes. The ribs and paddles are much dislocated, and the lower part of the tail is wanting. The length of the head is 2 feet 8 inches, of the whole fragment 7 feet. It has been admirably photographed by Mr. Elkington, of Bradwell, Rugby, to whom we were indebted for the first monster, and who will supply copies to geologists and others requiring them. It is hoped that the fossil may be secured for the Warwick Museum.

W. T.

Chemists and Chemical Industries.

APART from any question of good taste, it was surely quite unnecessary for Dr. Armstrong to import personal matters into the discussion in which he takes part in his letter appearing in your issue of the 9th inst.

The causes of the relative positions of this country and Germany as regards chemical manufactures, whether due to the real or supposed laches of particular manufacturers or not, are due to national not individual failings, and were admitted so many years back that they have little interest to-day. Moreover, they were not under discussion.

The question was—Whether the best means were being taken to remedy admitted defects in view of the fact that our most successful rivals were demanding what they believe to be improvements in their own methods of producing industrial chemists.

With these words, I will leave my friend Dr. Armstrong's version of "Who drives fat oxen should himself be fat," and pass back to our subject.

I gather, then, that the real cause of the alarm in Germany

is the energetic action of the Central Institution of the City and Guilds of London, &c. I frankly admit that I am rejoiced to hear it, and will thank God, therefore, though not in German, as is the way of superior people.

Some information on other points is, however, desirable to explain apparent anomalies.

For instance, why are we compelled, in Dr. Armstrong's phrase, to "expatriate our most capable students by Royal Commission?"

Why are the German laboratories so full of English and American students that names have to be taken in rotation, and in some cases instructions have had to be issued that preference is to be given to native students, and the number of foreigners limited?

Dr. Armstrong tells us that the education in "quite a number of our schools" is "even superior to that given in Germany." This is good news, and should soon attract—or perhaps it already has attracted—many students from Germany.

But, seriously, can one of our schools be named which, for building equipment and number of staff, is on a level with the best German examples?

Does Dr. Armstrong really mean to defend the use to which the education funds have been put by the counties and boroughs? Does he mean to say that the right persons have been charged with the duty of carrying on technical education? Does he think that a technical faculty could not be founded, or would have no value? Does he maintain that the sums spent—vast in the aggregate—have not been frittered away in teaching fragmentary science, &c., to people who do not need it?

If he says yes, then, regretting to differ, I must still maintain that while teaching as a rule has been, and is, too academical, the money would have been better employed had it been handed over to institutions such as his and Prof. Meldola's, for the purpose of founding technical faculties, for the erection of laboratories, and for the provision of more teachers in them, rather than in founding a host of places for teaching smatterings of science to artisans.

It seems to me to be a repetition of the errors of fifty years back. The originators of the "institutes" and "polytechnics" of the middle of the century made mistakes in a small way, and we are repeating them on a vast scale.

My critic says that this is not so, and that such a view gives an "entirely false impression."

I can only say that I heartily hope that I am wrong, for since no one has felt the opprobrium of the position more, no one will rejoice more if Dr. Armstrong's view is right.

In conclusion, may I add a word on Mr. Pope's letter in your issue of February 23. My withers are unwrung thereby, yet I can sympathise with those manufacturers who did refuse specimens. But there is another aspect of the question, than the easy acquisition of fine objects for the lecture table or laboratory museums for Mr. Pope, and those similarly placed, to consider, viz the grave responsibility that a teacher incurs when he even seems to advertise the goods of any particular manufacturer. That is why such goods should always be purchased, and thus all obligation avoided. R. J. Friswell.

March 11.

In the current number of the *Berichte*, the following advertisement appears:—"Eine grosse Anilin farbenfabrik sucht für das theoretische Laboratorium *gut geschulte Chemiker.* Praxis nicht erforderlich." Is not this a striking indication of the nature of the material from which the so-called "German technologist" is evolved, and of the methods by which Germany has attained so great a success in chemical industry?

William A. Davis.

Central Technical College, Exhibition Road, March 11.

Sunspots and Weather.

I have thought the following may be worth attention.

Count the number of *warm* months, and the number of *wet* months, at Greenwich, in each year, since 1841 (*i.e.* months above average in either case). Select the values in each of the five-year groups having a sunspot maximum year central; and the same with minimum.

This gives twenty-five numbers of warm months to be compared with twenty-five numbers of wet months, for sunspot *max.* groups; and like numbers for *min.* groups.

These may be compared by means of dots; using the ordinat[es] for warm months, and the abscissæ for wet months. The avera[ge] of warm months is six, that of wet months about five.

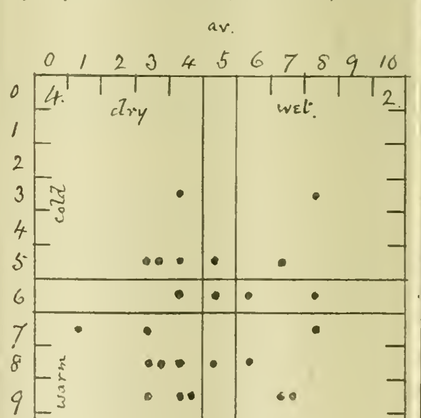
Minimum sunspot groups.

Cold and dry	5	Cold and wet	
Warm and dry	1	Warm and wet	

Totals—Cold, 14; warm, 7; wet, 13; dry, 6.

Some interesting contrasts come out.

Thus, in the *minimum* groups, there is only *one* year bo[th] warm and dry (1868); in the *max.* groups, *eight.* In the latt[er] only *two* years both wet and cold; in the former, *six.*



Maximum sunspot groups.

Cold and dry ...	4	Cold and wet	2
Warm and dry	8	Warm and wet	4

Totals—Cold, 7; warm, 14; wet, 8; dry, 13.

Compare, too, the total, cold, warm, wet, and dry, as at f[oot] of diagram. Alex. B. MacDowall.

THE CHEMISTRY OF THE STARS IN RELATION TO TEMPERATURE.[1]

THE recent advances in our knowledge which have come from the combination and interaction of solar, stellar and laboratory research, carried on by the aid of instruments of much greater power than those formerly used, have given us a firm chemical hold on all the groups of stars in my classification of them. These groups were established by discussing sequences of lines before the origin of the lines had been made out. A series of hieroglyphics is now replaced by chemical facts; and we can now study the chemistry of the stars, as well as their order in a system of classification.

The first question which naturally arises is this: Do the chemical elements make themselves visible indiscriminately in all the celestial bodies, so that practically, from a chemical point of view, the bodies appear to us of similar chemical constitution? This is not so.

From the spectra of those stars which resemble the sun, in that they consist of an interior nucleus surrounded by an atmosphere which absorbs the light of the nucleus, and which therefore we study by means of this absorption, it is to be gathered that the atmospheres of some stars are chiefly gaseous, *i.e.* consisting of elements we recognise as gases here, of others chiefly metallic, of others again mainly composed of carbon or compounds of carbon.

Here then we have spectroscopically revealed the fact that there is considerable variation in the chemical constituents which visibly build up the stellar atmospheres.

This, though a general, is still an isolated statement. Can we connect it with another?

By means of one of the first principles of spectrum analysis we know that the hotter a thing is, the light of which produces a continuous spectrum, the further does the spectrum stretch into the violet and ultra-violet.

Hence the hotter a star is, the further does its complete or *continuous* spectrum lengthen out towards the ultra-violet, and, *caeteris paribus*, the less is it absorbed by cooler vapours in its atmosphere.

Now to deal with three of the main groups of stars, we find the following very general result:—

Gaseous stars ...	... Longest spectrum.
Metallic stars ...	... Medium spectrum,
Carbon stars ...	... Shortest spectrum.

We have now associated two different series of phenomena, and we are entitled to make the following general statement:—

Gaseous stars ...	... Highest temperature.
Metallic stars ...	... Medium temperature.
Carbon stars ...	... Lowest temperature.

Hence the differences in apparent chemical constitutions are associated with differences of temperature.

This, then, is the result of our first inquiry into the existence of the various chemical elements in the atmospheres of stars generally. We get a great diversity, and we know that this diversity accompanies changes of temperature. We also find that the sun, which we independently know to be a cooling star, and Arcturus, are identical chemically.

I next pass from the general to the particular, and give the detailed results recently obtained in the case of stars as hot or hotter than Arcturus—taking Arcturus to represent the solar temperature.

In a paper on the "Chemistry of the Hottest Stars,"[2] in 1897, I stated the results so far arrived at concerning the order in which certain spectral lines appeared, and others disappeared, in stars arranged in a series of ascending temperatures.

[1] This article embodies a paper read at the Royal Society on Thursday, February 23.
[2] *Proc. Roy. Soc.*, vol. lxi. p. 148.

Since that paper was written many important advances have been made, among them I may mention the following:

Proto-metals.

With regard to the metals, the recent work on the enhanced lines in the spectrum of metals, α Cygni[1] and the sun's chromosphere enables us to deal with the lines observed at the highest temperature in the spectra of the following substances: magnesium, calcium, iron, manganese, nickel, chromium, titanium, copper, vanadium, strontium, silicium.

The accompanying untouched reproductions of photographs will show the wonderful similarity which exists between these three spectra.

As we have to deal both with the arc and spark lines of these substances, for the sake of clearness I call the latter "*proto-metallic*" lines, and consider the substances which produce them, obtained at the highest available laboratory temperatures, "proto-metals," that is, a finer form of the metal than that which produces the arc lines, corresponding to the "meta-elements" imagined by Crookes.

The temperature ranges of the enhanced lines of these metals have been investigated in various stars with the following results:—

Metal.	Range of temperature (upward series).	Range of temperature (downward series).
Magnesium	α Ursæ Min. to γ Argûs	α Eridani to Procyon
Calcium ...	α Tauri to γ Argûs	α Eridani to Arcturus
Iron ...	α Tauri to ζ Tauri	β Persei to Arcturus
Titanium...	α Tauri to ζ Tauri	β Persei to Arcturus
Manganese	α Ursæ Min. to α Cygni	β Persei to Procyon
Nickel ...	α Ursæ Min. to α Cygni	β Persei to Procyon
Chromium	α Ursæ Min. to α Cygni	γ Lyræ to Procyon
Vanadium	α Ursæ Min. to α Cygni	Sirius to Procyon
Copper ...	α Ursæ Min. to α Cygni	β Persei to Procyon
Strontium	α Tauri to α Cygni	Sirius to Arcturus

I pointed out in the note referred to that the enhanced lines of the above substances seemed to account for almost all of the more marked lines in α Cygni. It is on this ground that I have investigated their behaviour in other stars before waiting for the results of the complete inquiry. Another reason has been that, although in addition to the enhanced lines of the metals shown in the foregoing table, those of barium, cadmium, molybdenum, lanthanum, antimony, lead, palladium, tantalum, erbium and yttrium, tungsten, cerium, uranium, cobalt and bismuth have already been investigated with lower dispersion, and a spark obtained with the use of a much less jar capacity, so far I have no certainty that any of these substances exist in the reversing layers of stars of intermediate temperature.

The temperature ranges of the arc lines of some of the metals have also been investigated, and the results are shown in the following table:

Metal.	Range of temperature (upward series).	Range of temperature (downward series).
Iron ...	α Tauri to α Cygni	α Canis Majoris to Arcturus
Calcium ...	α Tauri to α Ursæ Min.	α Canis Majoris to Arcturus
Manganese	α Tauri to α Ursæ Min.	α Canis Majoris to Arcturus

So much, then, for the metals. I now turn to the gases.

Proto-hydrogen.

Some little time ago Prof. Pickering, of Harvard Observatory, found on examining the spectra of the

[1] NATURE, February 9 (p. 342).

southern stars, that one of them on the poop of the ship which forms the constellation Argo, hence called ζ Puppis, contained a system of lines not hitherto recognised, and he naturally concluded that it indicated a new element.[1] On further inquiry he found reason to suppose that this new series was in some way connected with hydrogen, since the lines occupied the same positions as those computed from the same formula and constants from which the ordinary series of hydrogen was calculated, the only difference in the employment of the formula being that even values of n were used instead of odd values.

Profs. Pickering and Kayser both concede that this new form of hydrogen is due most probably to a high temperature, and Prof. Kayser expressly states "that this series has never been observed before can perhaps be explained by insufficient temperature in our Geissler tubes and most of the stars."

If, as suggested both by Prof. Kayser and myself, this new series and the one previously known are probably of the subordinate type, the principal series of hydrogen is still beyond our ken, unless indeed one of the still "unknown" lines represents it, as suggested by Prof. Rydberg. Another possibility is that, even in the hottest stars so far considered, the temperature is not high enough to allow its molecule to exist uncombined.

On the view that the new series of probable hydrogen lines in ζ Puppis represents the effect of a transcendental temperature, an attempt has been made to produce this spectrum in the laboratory. In the high-tension spark in hydrogen at atmospheric pressure the ordinary series of hydrogen lines is very broad. The use of the spark with large jars in vacuum tubes results in the partial fusion of the glass and the appearance of lines which have been traced to silicium, but the new series has not yet been observed.

In his first communication, Prof. Pickering mentions lines at 4698, 4652, 4620, and 4505, but he does not refer to them in his second paper, which has special reference to the new series. The line 4505 was at first taken to be one of the components of the new series, but this seems to have been subsequently superseded by the employment of the line about 4544, which agrees better both as regards intensity and the calculated position 4543·6.

As this new hydrogen series seems to bear the same relation to the well-known one as the proto-metallic lines bear to the metallic, I call the gas which produces it proto-hydrogen for the sake of clearness.

The new series of lines discovered by Prof. Pickering has been found in the spectra of ζ, ε, δ and κ Orionis photographed at Kensington in 1892.

Prof. Pickering himself has since found this system of lines in other stars than ζ Puppis, and Mr. McClean, in his admirable work on the brightest stars of the southern hemisphere, has obtained photographs of the spectrum of γ Argûs, and on which the new series appears.

From a discussion of these stars in relation to the others photographed, there can be little doubt that we are here face to face with the very hottest stars so far known, and that the new series of hydrogen lines represents one among the last stages of chemical simplification so far within our ken.

We are, therefore, now in a better position to determine the relation of this new gas to other gases, both known and unknown, appearing in stars of nearly equal temperature.

Other New Gas Lines.

But even with our present knowledge of stellar spectra we find that in relation to the hottest stars there are still some gaps in our chemical knowledge; not only is this so, but have we any right to assume, taking into account the limitations of our means of observation and of the strict limitation of our observations to the relatively small part of space nearest us, enormous though it is, that we are as yet really in touch with the highest stellar temperatures?

Again, we cannot be certain that the small number of stars as yet studied puts us in presence of the highest stellar temperatures. Those stars which apparently are at the very apex of the temperature curve are involved in unknown lines, and require a special study.

Two typical unknown lines have wave-lengths at 4089·2 and 4649·2,[1] and besides these three other unknown lines occur in γ Argûs.

As these most probably reveal still undiscovered gases, I include them in the following table showing the limits

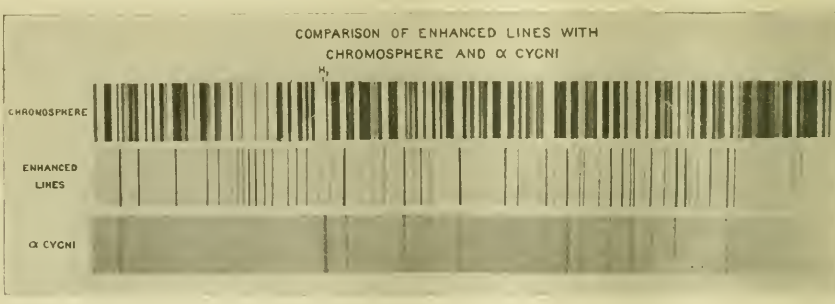


Fig. 1.

Origin.	λ of chief lines	Range in ascending series of stars.	Range in descending series of stars.
Unknown.	4457, 4451, 3876	Seen only in γ Argûs.	
Hydrogen (New).	4544·0, 4200·4	ζ Orionis to γ Argûs.	No stars available.
Unknown.	4089·2	α Crucis to ζ Orionis.	
Unknown.	4649·2	,,	α Eridani.
Helium.	4471·6, 4026·3	Rigel to γ Argûs.	α Eridani to γ Lyræ.
Asterium.	4388, 4009	Rigel to γ Argûs.	α Eridani to γ Lyræ.
Hydrogen.	Complete Series.	Aldebaran to γ Argûs.	α Eridani to Arcturus.

[1] See *Astrophysical Journal*, iv. p. 369, and v. p. 95.

[1] *Proc. Roy. Soc.*, vol. lxii. p. 52.

of stellar temperature to which the various known and unknown lines, probably of gaseous origin, extend.

Mr. McClean has stated that certain of the oxygen lines (amongst which is the strong triplet at λλ 4070·1, 4072·4 and 4076·3) appear in the spectrum of *β* Crucis and other stars of nearly equal temperature. My own observations, so far as they have gone, tend to confirm this view; but other photographs and more laboratory work are needed to explain certain changes of intensity which have been observed. The lines attributed by Mr. McClean to oxygen have been noted between *a* Crucis and *ζ* Orionis in the upward series, and in stars at about the *a* Eridani stage of temperature in the downward series.

There is evidence that the strongest lines of nitrogen at λ 3995·2 and λ 4630·9 make their appearance in stars at about the temperature of *a* Crucis. These lines appear from Rigel to *ζ* Orionis in the upward series, and are present in the stars at the *a* Eridani stage in the downward.

I pointed out many years ago[1] that at high temperatures the flutings of carbon in the violet are replaced by a line at λ4267·5. There is a line at this wave-length in the spectra of stars ranging in temperature from that of Rigel to *ζ* Orionis on the up side, and from *a* Eridani to *β* Persei on the down side of the temperature curve.

There is no known line of gases or metals to which this line can be assigned. It is probable, therefore, that carbon exists in stars of the same temperature as that at which oxygen and nitrogen have been traced.

Two lines in the spectrum of Silicium (λ4128·5 and λ4131·5) have been traced in stars between the temperatures of *a* Ursæ Min. and *a* Crucis in the upward series, and between those of *a* Eridani and Procyon on the downward.

The accompanying map shows the facts relating to stars as hot as, or hotter than, the sun, as we know them at present.

[1] *Proc. Roy. Soc.*, vol. xxx. p. 461.

Description of Map.

The map is arranged on the following plan. The temperature of the sun and Arcturus forms the lowest stage. The upper limit is defined by *γ* Argûs, the hottest star so far known. On the left the stars named are those of increasing temperature, on the right those of decreasing temperature. Those on the same horizon represent equal mean temperatures so far as the cleveite gas and enhanced lines help us to determine them. The blank spaces indicate that so far no star has been photographed in the spectrum of which the enhanced lines exactly match those on the opposite side.

The names of the various chemical substances included in the discussion are given at the top. I have retained the prefix "proto" to that condition of each metallic vapour which gives us the enhanced lines alone, and I have added it to that form of hydrogen seen only in the hottest stars.

The behaviour of the most typical line of each chemical substance is indicated by a double line looped at the top at its highest range. The length and varying thickness of the lines in stars on both sides of the temperature curve are derived from the observed appearance and intensity of the lines, noted in the different stars.

The wave-lengths of the lines discussed are shown at the bottom of the map.

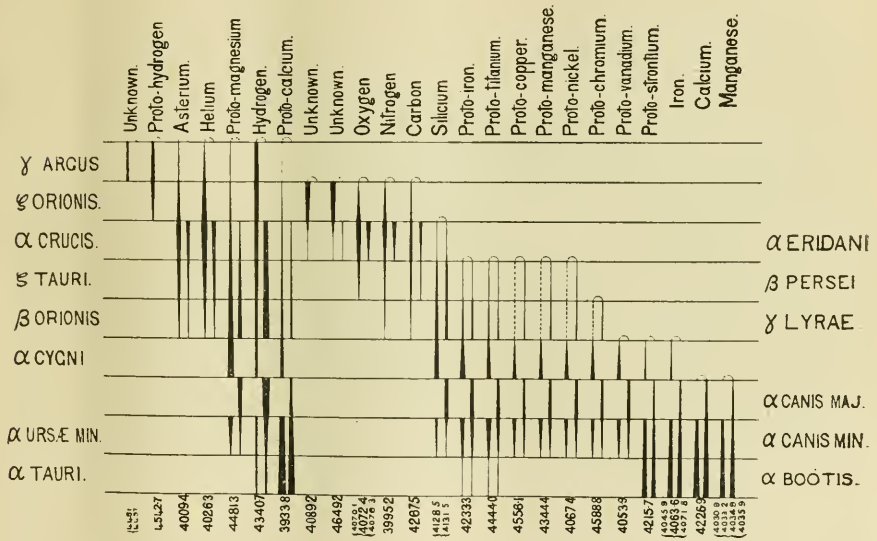


FIG. 2.

Details of Changes observed.

The facts embodied in the map present to us the spectral changes noted in stars of Groups III., IV. and V. of my classification,[1] and are a result of a more general inquiry than those referred to in my previous papers,[2] the origins of a very considerable number of stellar lines having since then been traced to enhanced lines of metals and to known gases.

[1] *Proc. Roy. Soc.*, vol. xliii. p. 117 (1887).
[2] *Proc. Roy. Soc.*, vol. xliv. p. 1 (1888); *ibid.*, vol. xlv. p. 380 (1889); *Phil. Trans.*, 184A, 1893, p. 725.

It will be seen that this more general inquiry entirely justifies the prior statement[1] that the metallic lines are thickest in stars increasing their temperature, and the hydrogen lines thickest in stars decreasing their temperature, in other words, on the opposite arms of the temperature curve. I have already stated a possible explanation.[2]

It will be observed that, so far, I have not been able to find stellar spectra on the downward side corresponding to those of γ Argus and ζ Orionis; but it is more than probable that near the apex of the curve only a small change, will be observed; their default, therefore, is of less consequence than it might have been.

The same remark applies to α Cygni and Sirius; but here it is certain that the differences in the relative intensities of the gaseous and enhanced lines will be considerable, judging from what happens above and below the heat stages represented by them.

The stars used in the discussion give us very definite results, showing that the various chemical forms are introduced at six very distinct heat levels.

The Temperature Ranges.

I next proceed to make some remarks upon the series of facts now for the first time brought together; it must, however, be borne in mind that all the chemical elements and all parts of the spectrum have not yet been included in the survey.

(1) Hydrogen appears throughout both series of stars from top to bottom. Proto-magnesium and proto-calcium follow suit very nearly; but the highest intensity of the former is reached at the stage represented by α Cygni, and of the latter at the solar temperature represented by α Tauri and Arcturus.

(2) With the above exceptions all the chemical forms so far traced are relatively short-lived.

This is the first important differentiation. In the light of (1) we are justified in assuming that the substances in (2) would be visible in the stellar reversing layers if they were there.

(3) In the stars of higher temperatures we deal generally with gases. Below the stages represented by β Orionis and γ Lyræ we deal with proto-metals and metals, hydrogen being the only exception.

(4) The proto-metals make their appearance at about the same heat-level at which the gases (with carbon), always excepting hydrogen, begin to die out.

This is the second important differentiation. It is interesting to notice the distinct difference of behaviour of carbon and silicium in the descending series; the former goes through the same stages as oxygen and nitrogen, the latter behaves like the proto-metals.

(5) With the exception of iron the metals, as contradistinguished from the proto-metals, only make their appearance in stars at and below the heat-level of Sirius.

This is the third important differentiation. It is accompanied with a notable *diminution* of hydrogen and proto-magnesium, and with an *increase* of proto-calcium; indeed, the latter seems generally to vary inversely with the hydrogen.

In all these changes we seem to be brought into presence of successive polymerisations due to reduction of temperature. Of the origin of proto magnesium and proto-calcium the stars as yet tell us nothing; but it is difficult to believe that the earliest forms of the other metals are not built up of some of the constituents of the heat ranges represented by those between γ Argus and α Crucis.

The question arises whether the order of visibility at reduced temperatures now indicated does not explain the absence of proto-hydrogen, oxygen, and nitrogen from the spectra of the sun and nebulæ; the metals present in, and the absence of quartz from, meteorites, and the similarity of the gaseous products obtained from meteorites and metals, native and other, in vacuo at high temperatures.

NORMAN LOCKYER.

[1] *Proc. Roy. Soc.*, vol lxi. p. [illegible]
[2] *Proc. Roy. Soc.*, vol. lxi. p [illegible]

THE INSTINCTS OF WASPS AS A PROBLEM IN EVOLUTION.[1]

THIS work has been looked forward to with the deepest interest by all naturalists who are familiar with Dr. and Mrs. Peckham's observations upon the courtship of the spiders, and who were aware that this long-continued and laborious research had been undertaken by them. The observations and conclusions of M. Fabre upon the instincts of the solitary wasps have been so often quoted, and have formed the foundation of so large a superstructure of theory, that it became of the highest importance that they should be repeated by other naturalists. The late George Romanes and many other writers on evolution have always looked upon these observations as the strongest of all arguments for a Lamarckian instead of a Darwinian interpretation of instinct. Thus Romanes wrote in "Mental Evolution in Animals": "Several species of the Hymenoptera display what I think may be justly deemed the most remarkable instincts in the world. These consist in stinging spiders, insects, and caterpillars in their chief nerve centres, in consequence of which the victims are not killed outright, but rendered motionless; they are then conveyed to a burrow previously formed by the *Sphex*, and, continuing to live in their paralysed condition for several weeks, are at last available as food for the larvæ when they are hatched. Of course the extraordinary fact which stands to be explained is that of the precise anatomical, not to say physiological knowledge, which appears to be displayed by the insect in stinging only the nerve centres of its prey" (quoted by the authors on pp. 221, 222). A still more imaginative description is also quoted (on pp. 220, 221) from Eimer, who says: "This is one of the most marvellous instincts that exist; since the wasp operates on various larvæ with nervous systems of various forms, she must effect the paralysis in various ways, and even apart from this, she makes a physiological experiment which is far in advance of the knowledge of man. . . . It may be suggested that the wasp only paralysed the larvæ in order to carry them more easily; but even if this were the case, she must, since she now invariably acts in this way, have drawn a conclusion by deductive reasoning. In this case it is absolutely impossible that the animal has arrived at its habit otherwise than by reflection upon the facts of experience." The authors truly say of these remarks, and the rest of the quotation from Eimer: "One can hardly be expected to take such statements seriously, since it is certain that the writer has no knowledge of the life-histories of these insects." Eimer and Romanes were both quoting from Fabre, and, relying upon his inferences even more fully than upon his observations, they both held that a Lamarckian interpretation is inevitable. Such instincts, they maintained, can only have arisen by the inheritance of the results of intelligent observation. In order thoroughly to test the foundation upon which such far-reaching conclusions have been built, Dr. and Mrs. Peckham have carefully observed all the species of solitary wasps which they could find in their beautiful summer home, with Dr. C. A. Leuthstrom, on Pine Lake, Wisconsin. As in the case of other insect orders, these Hymenoptera have a wonderfully familiar look to an

[1] "On the Instincts and Habits of the Solitary Wasps." By George W. Peckham and Elizabeth G. Peckham. Wisconsin Geological and Natural History Survey *Bulletin* No. 2 Scientific Series No. 1. (Madison, Wis.: published by the State, 1898.)

English zoologist, the same genera and closely similar species occurring in very large numbers. The present writer has had the great privilege, in the summer of 1897, of seeing Dr. and Mrs. Peckham at their work, and of discussing with them many of their results.

The habits of one or more species of the following genera were studied with the utmost care, and are described in Chapters i.–xiv.: *Ammophila*, *Sphex*, *Rhopalum*, *Stigmus*, *Crabro*, *Salius*, *Aporus*, *Bembex*, *Oxybelus*, *Trypoxylon*, *Astata*, *Diodontus*, *Cerceris*, *Philanthus*, *Pompilus*, *Agenia*, *Tachytes*, *Lyroda*, *Priononyx*, *Chlorion*, *Harpactopus*, *Pelopaeus*.

It will be admitted that the careful study of species in these twenty-two genera constitutes a serious amount of evidence which entitles the authors' conclusions to the most careful consideration.

Chapter xv. contains a *résumé* of the most interesting observations and conclusions in Paul Marchal's important monograph on *Cerceris ornata*. Chapter xvi. is devoted to the sense of direction; xvii. to the stinging habit in wasps; while Chapter xviii. states the conclusions upon the instinct and intelligence of wasps, which the authors believe to be justified by their observations.

The fourteen plates are skilfully drawn by J. H. Emerton, who illustrated the authors' works on spiders. Plates I. and II. contain excellent coloured illustrations of thirteen of the species whose habits are described; the remaining plates are uncoloured. Plates III., IV. and V. deal with the habits of *Ammophila urnaria*, the most interesting of the species which were studied. Fig. 1 is a reproduction of Plate IV. (p. 11), and shows the manner in which *Ammophila* stings the caterpillars, which it stores up in the burrow in which it lays its egg. After much patient watching the whole process was observed from beginning to end on three occasions. On the first of these the caterpillar was first stung on the ventral surface between the third and fourth segments. "From this instant there was a complete cessation of movement on the part of the unfortunate caterpillar, which was then stung between the third and the second, and between the second and the first segments. The wasp then circled in the air above the caterpillar, "and then, descending, seized it again, further back this time, and with great deliberation and nicety of action gave it four more stings, beginning between the ninth and tenth segments and progressing backward." The second wasp also stung the third, second, and first segments in order; and then she went on to sting the fourth, fifth, sixth and seventh, but stopped at this point, proceeding, however, to bite the neck of the caterpillar in a very thorough manner (malaxation). In the third example the wasp gave one sting between the third and fourth segment, and then spent a long time in biting the neck. In this case, however, the caterpillar had been placed by the observers in the way of the wasp, and she seemed rathe. indifferent to it.

I have quoted these observations at some length because a closely allied European wasp (*A. hirsuta*) seems more than any other species to have afforded the evidence relied upon by Fabre and those who have followed him. By the study of but nine wasps of the same genus, and fifteen caterpillars, the American naturalists have shown that the immense superstructure which has been raised on so small a foundation is in large part due to a fertile imagination. So far from the assumed perfection and accuracy with which every detail is supposed to be repeated, the instinct is shown to be excessively variable. The frequently quoted conclusions that the object of the sting is to reduce the larva to helplessness and yet to keep it in a fresh condition, that a dead larva would be unsuitable food and an active one a danger to the offspring of the wasp—all these conclusions are entirely disposed of by a few carefully specially directed observations. These show that the larva rapidly dies in a large proportion of cases and yet affords excellent food, and that it may remain sufficiently

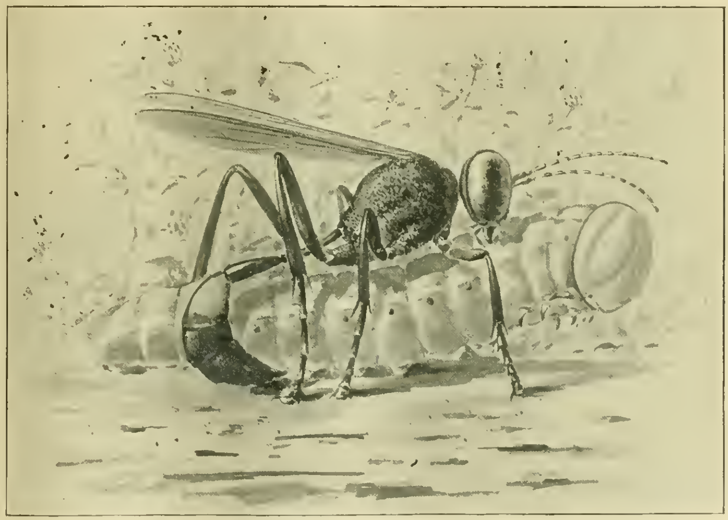


FIG. 1. *Ammophila urnaria*, stinging caterpillar.

uninjured to wriggle continuously without stimulation, or to move violently when bitten by the larva of the wasp.

The fifth plate (p. 23) is reproduced in Fig. 2, and shows *Ammophila urnaria* using a stone to pound down the earth with which the entrance to the burrow is covered. This very interesting observation is confirmed by the study of *Ammophila Yarrowi* in Western Kansas by S. W. Williston.

The remaining plates show the appearance of many other species which were studied, and also include representations of their burrows, prey, and several very interesting "locality studies" made by wasps of many species before they leave a freshly dug burrow to seek for prey. The representation of these complex movements in the neighbourhood of the burrow strongly supports the authors' conclusions in favour of the dominant importance of the sense of sight in these Hymenoptera—ations on this point are greatly needed, including a long series of experiments in which wasps of many kinds are held in the forceps and made to sting their natural prey in various parts of the body. The question of malaxation suggests another most interesting field of inquiry; in fact, the great value of the work depends as much upon its suggestive and inspiring spirit, as upon the full record of discovery which it contains.

The type is clear and good, although the quality of the paper leaves much to be desired. There are a few obvious misprints and erroneous references which will soon be detected by the reader.

The volume ends with the following paragraph—and the reader will admit that very solid grounds are given for the conclusions. "The general impression that remains with us as a result of our study of these activities, is that their complexity and perfection have been greatly overestimated. We have found them in all stages of develop-

FIG. 2. *Ammophila urnaria* using stone to pound down earth over nest.

conclusions which they also support by many other observations and experiments.

The following activities or performances are regarded as truly instinctive: stinging, the methods of attack, capture and carriage of prey peculiar to each species, the kind of prey selected, the general style and situation of the nest, the form of cocoon.

If the exigencies of space permitted, it would be of great interest to discuss many of the points raised in this valuable research. It is only possible on the present occasion to point to certain observations which indicate that the action of the wasp's poison on the ganglionic centres may be through the hæmolymph and not necessarily direct. If this be so, it disposes of the necessity for any great precision in the locality of the sting. A puncture *anywhere* would produce effect, although probably more rapidly and completely if made in the neighbourhood of a ganglion. Further observ-ment and are convinced that they have passed through many degrees, from the simple to the complex, by the action of natural selection. Indeed, we find in them beautiful examples of the survival of the fittest."

E. B. P.

SIR JOHN STRUTHERS, M.D., LL.D.

ON February 24 death removed from amongst us the *doyen* of the professors and teachers of anatomy in Scotland.

John Struthers was born at Dunfermline in 1823. He began to study medicine in the University of Edinburgh in 1841, and obtained the degree of Doctor of Medicine in 1845, when he wrote his thesis "On the Physiology and Physiological Anatomy of the Muscles and Nerves of the Eyeballs, and on the Theory of their Derangement

in Strabismus." In November of the same year he was elected a Fellow of the Royal College of Surgeons of Edinburgh. Two years later, the same College granted him a licence to teach anatomy in the Edinburgh extra-mural School of Medicine, and from that time to his retirement in 1889, he was continuously engaged in teaching anatomy by lectures and in the dissecting room.

In 1863, on the death of Prof. Alexander Lizars, he was appointed by the Crown to the chair of Anatomy in the University of Aberdeen, an office which he held for twenty-six years.

During the early years of his teaching in Edinburgh, where he was preparing himself for the professorial position which he subsequently attained, he proved to be a hard-working and laborious teacher. Although for a time he held a surgical appointment in the Royal Infirmary, his heart was in anatomical work, and he found that to preserve his position in the School it became necessary to give his whole time to the anatomical class. The chair of Anatomy in the University during the period when Dr. Struthers was lecturing in the extra-mural School, was filled by Prof. John Goodsir, a great philosophical anatomist and original investigator. By a strict attention to his duties, by the mastery of detail and a faculty of lucid exposition, Struthers obtained a reputation which attracted students; so that his class became satisfactory as regarded numbers, and his position as a teacher was so well assured, that during Goodsir's illness in the session 1853-54, Struthers was appointed to undertake the duties of the chair of Anatomy.

On his appointment to the chair of Anatomy in Aberdeen in 1863, he found the arrangements for anatomical teaching in that University to be in a crude and backward condition. With the energy and power of steady application, which were so characteristic of the man, he at once set himself to develop the methods of teaching, and to make them worthy of a University course, so that the reputation of the chair was greatly increased, and the number of the students attending the class was more than doubled. He employed both his voice and pen in promoting the raising of funds for the construction of new buildings, in which not only his own, but the other branches of medical study could be properly taught, and he contributed in a very material manner to the prosperity which attended medical and scientific education in the University of Aberdeen.

There can be no doubt that, in carrying out the reforms which he was so instrumental in procuring, he had many hard battles to fight against the prejudices and imperfect conceptions of what was required in the modern teaching of medicine, held by many of his colleagues, more especially in the faculties of arts and theology. It required a man of great determination of character, who knew what was wanted, and would not readily acccept a defeat, to raise to their proper level, and in accordance with the needs of the time, the buildings and materials required for medical and scientific teaching. Although much in addition has been done during the ten years that have elapsed since Struthers retired from the chair, the spirit of improvement which he had been so largely instrumental in developing has continued to grow under the direction of his later colleagues and successors.

This is scarcely the place to dwell on the attention which Sir John Struthers gave to the public relations of his profession. One cannot, however, overlook the fact that he took a great practical interest in the efforts which were made between 1850 and 1886 to promote medical legislation, and to provide for the service of the public a medical practitioner possessing a higher standard than formerly of general and professional education. As representing his University for some years on the General Medical Council, he was most active in the discussions which led to the period of medical education being raised from four to five years before a diploma could be obtained. When, on his retirement from the Aberdeen chair, he went to reside in Edinburgh, he became a manager of the Royal Infirmary in that city, and did good service in developing the means afforded by that great hospital for imparting clinical instruction, more especially in the special departments of medical and surgical practice.

The Royal College of Surgeons of Edinburgh recognised his professional services and his attachment to the College which had granted him, in his early life, his licence to teach, by making him from 1895 to 1897 its president. During this period he devoted much of his time to the reorganisation of the museum of the College, and he contributed to it many valuable anatomical specimens.

Sir John Struthers was a voluminous writer on several branches of anatomical science, although, as he often used to say, the time which he required to devote to teaching, to University business and to the consideration of the public relations of his profession greatly curtailed the hours which he was able to give to research. His most noteworthy investigations, those which probably more than any other of his contributions to science will give him a permanent position in anatomical literature, were his memoirs on the anatomy of the Cetacea, more especially on the Whalebone whales. They were for the most part, if not entirely, printed in the *Journal of Anatomy and Physiology*, and his memoir on the anatomy of the Hump-backed whale, which gives the most detailed account of its skeleton that has yet been published, was subsequently reproduced in a separate volume.

The chief characteristic of his anatomical writings was the minute attention paid to detail. He seemed to spare neither time nor labour in striving to give accuracy to his descriptions, a quality which to an anatomical writer is of fundamental importance. He, however, carried out his love of minute accuracy to such an extent that when he began to record variations in the weight of the clavicle, and expressed in fractions of an inch the diameters of the bodies and processes of the large vertebræ of a great whale, it is not an unfair criticism to make, that so ample a supply of detail is apt to obscure the essential characters of an object. The memoranda which he prepared, and the reports which he wrote on University and other public questions in which he was interested, displayed the same quality of laborious detail; so that we may say of Sir John Struthers, that he possessed an infinite capacity for taking trouble, and that he did work in his day and for his generation.

NOTES.

Dr. Helmert, professor of geodesy in the University of Berlin, and director of the Prussian Geodetic Institute, has been elected a correspondant of the section of geography and navigation of the Paris Academy of Sciences, in succession to Sir G. H. Richards.

A monument to Pasteur is to be unveiled at Lille on Sunday, April 9. On the same day the Pasteur Institute of Lille will be formally opened. M. Viger, Minister of Agriculture, and M. Guillain, Minister for the Colonies, will preside at the ceremonies.

We much regret to announce that Sir Douglas Galton, K.C.B., F.R.S., died on Friday last, at seventy-seven years of age.

Sir William Turner, F.R.S., professor of anatomy in the University of Edinburgh, has been elected president of the British Association for the Bradford meeting next year.

The *Lancet* states that the late Prof. Rutherford has bequeathed to Edinburgh University his valuable medical library and his physiological and microscopical specimens and diagrams.

In consequence of the forthcoming international geographical congress at Berlin, the thirteenth German Geographentag, which was to be held at Breslau this Easter, has been postponed until Easter of next year.

Sir Norman Lockyer, K.C.B., has been nominated by the Royal Society to succeed the late Rev Bartholomew Price as a member of the Board of Visitors of the Royal Observatory, Greenwich.

The third Congrès des Sociétés savantes will be held at Toulouse on April 4.

The next Congress of the South-East Union of Scientific Societies will be held at Rochester on May 25, 26 and 27.

The death is announced of Dr. Wilhelm Hankel, professor of physics in the University of Leipzig.

Major J. Evans, professor of pathology in the Calcutta Medical College, died on Monday from the plague.

The death is announced of Dr. Francis N. Macnamara, formerly professor of chemistry at the Calcutta Medical College, and chemical examiner to the Government of India. Upon his return to England after leaving the Indian Medical Service, he was appointed by the Secretary of State Examiner of Medical Stores at the India Office. He was about to relinquish this appointment when death overtook him, on March 5, at the age of sixty-seven. Dr. Macnamara was the author of a number of works and papers on hygiene and medical chemistry.

In connection with the second International Acetylene Congress, an international exhibition of acetylene gas will be held in Budapest in May next, when gold and silver medals will be awarded.

We learn that the physics garden of the Society of Apothecaries in Chelsea, founded by Sir Hans Sloane in 1722, is about to enter upon a new period of activity and usefulness. A physiological laboratory is to be built, a scientific curator appointed, and courses of lectures on different branches of botany are to be given.

It is stated in the *British Medical Journal* that a laboratory for the application of the Röntgen rays has recently been opened in Madrid, under the name of Instituto Radiografico de Españo. The Institute, the installation and equipment of which are on a magnificent scale, is said to have cost some two million pesetas (80,000*l*.). It is reported that the impression produced by the size of the place, the luxurious manner in which it is fitted up, and the wealth of apparatus which it contains, on the large assembly of medical men and journalists who were present at the opening, was one akin to stupefaction. The director of the Institute is Dr. Mezquita.

It is announced in the *Electrician* that E. P. Kaüffer, a member of the Verein Deutscher Ingénieure, who died in 1897, left this society a legacy, from which a first prize of 3000 marks, and a second of 1500 marks (about 150*l*. and 75*l*. respectively) are to be awarded for the best essay in reply to the question: "What practical and useful processes are available to transform heat directly (without motors) into electro-dynamical energy?" Herr Bissinger, Prof. Borchers, Prof. Dietrich, Herr Kapp and Dr. Kohlrausch have been chosen as judges. The competition is international, and is not confined to members of the Verein. Essays are to be written in German, and must be sent in before December 31, 1899, to the Verein Deutscher Ingénieure, 43 Charlottenstrasse, Berlin, N.W.

The St. Petersburg correspondent of the *Times* reports that the Russian Geographical Society is fitting out, with the aid of funds supplied by the Tsar, a new expedition for the exploration of Central Asia. The expedition, the work of which is intended to cover two years, is to be under the command of Lieutenant Koslow, and will leave St. Petersburg at the end of the present month. It will make its way through West Mongolia and the Desert of Gobi, will cross the Nan-shan Mountains by Lake Koko-nor, and penetrate into the region lying round the upper waters of the Yellow River.

The Department of Science and Art has received through the Foreign Office a communication from the Director of the Commercial Museum, Philadelphia, calling attention to a Universal Commercial Congress and Exposition to be held there, under its auspices, during the autumn of the present year. There is being erected for the purposes of the Exposition a series of buildings in which will be displayed such American manufactures as are most representative and best adapted to foreign requirements; but it is intended also to accept as exhibits similar articles from European manufacturers, in order to afford an opportunity for a thorough and comparative study of the world's industries. The Congress will be presided over by the President of the United States at the opening Session on October 10, and all nations will have an opportunity of being represented, and having a voice and vote in its deliberations, through duly accredited delegates sent by the various Governments and commercial organisations.

A new incandescent lamp, in which a filament consisting of the carbide of silicon, coated with silicon and carbon by means of a modification of the usual flashing process, has been invented by Herr Langhans. Particulars of the process of manufacture are given in the *Electrician*, from which we learn that owing to the refractory nature of the material used for the filaments, lamps thus made will stand being run at a higher efficiency than is possible with any carbon filament. As is only too well known by users of the glow lamp, its two great faults, which become more marked with every increase in the efficiency when *new*, are falling off in the light and the blackening of the bulbs as time goes on. Both these faults, notwithstanding the high efficiency, are said to be practically absent from the carbide of silicon lamp. It is claimed that the new lamp, starting at an efficiency of 2·8 watts per amyl-acetate candle (*i.e.* about 3·1 watts per English candle), will run from 600 to 800 hours without any material decrease in the light emitted, increase in the watts consumed per candle, or any blackening of the glass bulbs. So that, apart from the gain in appearance and comfort from the lamps remaining bright and clean, the user of this lamp should save, on this estimate, some 25 per cent. on his lighting bills, as compared with the expenses of the use of the ordinary carbon filament lamp.

The *Proceedings* of the Swedish Academy of Science, vol. xxxi., contains a discussion of the mean atmospheric pressure in Sweden for the years 1860–1895, by Dr. H. E. Hamberg. The work forms one of a series of valuable papers by the Meteorological Office at Stockholm, in commemoration of its twenty-fifth anniversary, and includes both tables of monthly and yearly mean values for thirty-four stations, and mean isobaric charts for the same periods. An examination of the annual variation shows that there are no less than four maxima and four minima. The first maximum, that of midwinter, occurs in January and February, and is most pronounced in the south of Sweden. It is produced by the deviation of the Asiatic high-pressure, which extends over parts of Europe. The second maximum occurs in spring, and is most marked in the north; it is apparently caused by the polar anticyclone, in

conjunction with the high pressure over part of the North Atlantic. The subsidiary maxima occur in September and November. The first minimum occurs in March, and is very marked. It appears to be due to the low pressure over the Atlantic, and to the diminution of the continental anticyclones. The second, or summer minimum, occurs in July and August. It is caused by cyclonic formations developed by the high temperature over Europe and Asia. The subsidiary minima occur in October and December.

IN the *Indian Meteorological Memoirs*, vol. vi. part iv., Mr. J. Eliot, F.R.S., discusses the occurrence and distribution of hailstorms in India during the fifteen years 1883–97. Information of all important hailstorms is collected by the revenue authorities, with the view of remitting the collection of part or the whole of the land tax over the affected areas, and Mr. Eliot has wisely arranged for copies of the data to be supplied to the Indian Meteorological Office. In the very interesting discussion, he points out that 94 per cent. of the hailstorms occur during the north-east, or dry monsoon (December to May), when the diurnal range of temperature is large, and that they are almost entirely absent during the south-west, or wet monsoon (June to November). A noteworthy feature of the distribution is that in certain districts the storms occur chiefly during the first part of the dry monsoon, *i.e.* during the cold weather season, while in other provinces they originate chiefly during the hot weather. As regards the diurnal distribution, during the hot weather period the hailstorms occur chiefly (about 74 per cent. of the total number) between 3 p.m. and 8 p.m. In the cold weather season, they are most frequent during the hottest time of the day, 3 p.m. to 4 p.m.

WE are glad to learn from a Report, just published, that the stimulus supplied by the visit of the British Association to Bristol last year, and the special efforts made by the Committee, have resulted in increased interest being taken in the Bristol Museum, one consequence of which has been a succession of valuable gifts to the collections. In April 1898 an important discovery of animal remains belonging to the Pleistocene period was made at Uphill, near Weston-super-Mare. Steps were at once taken by the Committee to secure for the museum collections the results of an exploration of the site. The exploration was carried on as far as was possible at the time, and the result has been that a large and representative collection of the bones and teeth of animals, including those of the hyena, mammoth, horse, cave-bear, cave-lion, rhinoceros, fox, &c., has been secured. Peculiar interest attaches to certain other bone fragments that have been identified as those of man, and to a small collection of chipped flints and rounded stones. A selection from these interesting objects was exhibited by the present curator, Mr. Herbert Bolton, at the British Association, and he also communicated the substance of the notes on the subject of the exploration, left by his predecessor, Mr. E. Wilson. The Council of the Association have shown their interest in the matter by making a grant of £30—towards any further expense, and the Chairman of the Committee (Mr. W. R. Barker) and Mr. Bolton are now associated with Prof. C. Lloyd Morgan, Prof. W. Boyd Dawkins, and others, in determining what further can be done.

THE Hayti earthquake of December 29, 1897, is the subject of an interesting paper, by Dr. G. Agamennone, in the last *Bollettino* of the Italian Seismological Society. The epicentre was situated in the valley of the river Yaque, in lat. 19½° N. and long. 71° W., and the intensity in this district was from 9 to 10 of the Rossi-Forel scale. The total disturbed area was not less than 125,000 square km.; but, as usual, the seismic waves were recorded by pendulums in distant observatories, the furthest being that of Nicolaiew, 9370 km. from the origin. The earlier tremors travelled with a velocity of about 10 km. a second, and the subsequent slow pulsations with a velocity of about 3 km. a second. The estimates of the period of the latter vary with the instrument employed, ranging from seven seconds at Rocca di Papa, near Rome, to eighteen seconds at Catania.

WE have received the first instalment of a "Catalogue of the Types and Figured Specimens in the Palæontological Collection of the Geological Department, American Museum of Natural History," issued as vol. xi. part 1 of the *Bulletins* of that Museum. The importance of the proper cataloguing of type-specimens of fossils needs no pointing out, and the work before us, prepared by Mr. R. P. Whitfield, assisted by Mr. E. O. Hovey, is a model of clear and careful arrangement. The specimens are arranged firstly according to geological systems, secondly in biological classes, and then alphabetically. Generic names appear in Clarendon type, species in Roman, and synonyms in italics. The catalogue is arranged in seven columns, stating in turn (1) the geological series (initials only); (2) catalogue number; (3) whether "type" or "figured"; (4) genus, species, and author; (5) reference—subdivided into five columns for work, volume, page, plate, and figure; (6) locality; and (7) remarks. The only improvement that we would suggest is the printing of the name of the geological system on *every* page, instead of only once. The present part covers the Cambrian and Lower-Silurian systems.

THE third instalment of the International Geological Map of Europe, which has recently been issued, is specially interesting to British geologists from its containing the three sheets that cover the British Isles (A4, B3, and B4). For the sake of symmetry, sheet A3 is added, but this resembles a certain famous map in "representing the sea without the least vestige of land"; while A4 contains such a small fragment of Ireland that the margin of B4 has been broken, and the fragment repeated there, the two sheets B3 and B4 thus including the whole of the islands. The British Isles, treated from the international point of view, present a somewhat unfamiliar aspect. This is due not so much to violet Trias and blue Jurassic as to the representation of Drift. Ireland, in particular, is one mass of stripes, indicating known older strata covered by quaternary. As no allowance is made in the Index of Colours for non-metamorphic pre-Cambrian beds, the Longmynd and Charnwood Forest have perforce to reappear as "Cambrian"; but the insertion of such comparative novelties as the Permian of Devonshire, and the Cambrian of the north-west Highlands clears the map of any suspicion of being out of date. Besides the British sheets the new issue includes C5, which forms by itself an excellent map of the Alps, and D5 and D6, which take in most of Austria-Hungary, the Balkan peninsula and Greece.

AT the Institution of Civil Engineers on March 7, two papers relating to recent advances in marine engineering were read. The first paper, on "Water-Tube Boilers for Marine Engines," by Mr. J. T. Milton, consisted mainly of a description of the various types of water-tube boilers most in use for marine purposes in this country. For all recent vessels of the Royal Navy water-tube boilers of dfferent type had been adopted, while very few had been fitted in merchant steamers. The second paper, on "Machinery of Warships," by Sir A. J. Durston, K.C.B., and Mr. H. J. Oram, R.N., gave particulars and remarks on the construction of warship machinery and details of the results obtained since the date of the paper read at the Institution in November 1894. It was pointed out that further experience with water-tube boilers had led to their general adoption for warships. In considering the type most suitable,

the principal points to be considered were weight and space required, economy and durability. On account of the last two considerations, boilers of the large-tube type had been adopted for the larger vessels. The Belleville boiler was fitted in these vessels, and in recent cases these had been fitted with economisers, the number of tubes in the generators being reduced. Trials on shore showed 12 to 15 per cent. increase of economy due to the use of these economisers. In the smaller fast vessels, to reduce weight, boilers of the small-tube type were generally fitted. Experience had shown that the ordinary life of the tubes of the Belleville boiler, under ordinary circumstances, would be not less than two commissions. In small-tube boilers this life would generally be much less. Zinc slabs, though still of use in arresting corrosion, could not from the nature of construction of water-tube boilers be so effective as in water-tank boilers. The parts of the boiler near the feed-water inlet appeared to be very subject to corrosion, and this appeared to be due to the liberation of air and other gases from the feed-water at this part. It was endeavoured to minimise this action by using distilled water whenever possible.

MR. E. F. J. LOVE has drawn up, for the Sydney session of the Australian Association for the Advancement of Science, a report on our knowledge of the thermodynamics of the voltaic cell. In it the author shows how the general laws of thermodynamics have been applied to the determination of electromotive force, Helmholtz's law, the Peltier effect, dissociation, the calculation of the free energy of the current, polarisation, and the relation between electromotive force and external pressure. It is pointed out that the results here exhibited as deductions from the laws of thermodynamics can in some cases be obtained independently by totally different methods.

AN extremely interesting and suggestive memoir, dealing with some investigations on the bacterial diseases of plants, has been contributed by M. Émile Laurent to the *Annales de l'Institut Pasteur*. The majority of the experiments were made with potatoes, cultivating them on soil variously treated with manures, chemical and other, and then inoculating the tubercles with a certain micro-organism closely allied to the *B. coli communis* obtained from the air during the course of the investigations. Different kinds of potatoes were selected, and, as was to be expected, the various chemical manures employed affected the luxuriance of the growth very differently; but the chief interest of these experiments lies in the fact that apparently susceptibility to bacterial infection varies not only with the variety of potato, but also according to its conditions of cultivation. Thus the bacterial susceptibility of several varieties was increased by their being grown on land liberally treated with lime. According to M. Laurent, speaking generally, lime added to soil increases the susceptibility of potatoes to bacterial infection, and nitrogenous and potash manures have the same effect, only to a less extent; whilst the addition of phosphates distinctly diminishes this susceptibility, as also does common salt, only not so markedly. Some interesting experiments are recorded, showing how the virulence of this bacillus towards potatoes can be artificially increased by suitable conditions of cultivation. Incidentally, we are told that the typhoid bacillus attacks potatoes with extraordinary energy if the resistance of the latter has been reduced by treatment with an alkaline solution; this activity of the typhoid bacillus being more marked than was the case with other varieties of bacteria which had had a far longer training. The memoir is replete with suggestive work, and affords a fresh outlet for the energies of those bacteriologists who care to study the micro-organisms in their relation to plant-life.

THE February number of the *Quarterly Journal of Microscopical Science* is almost entirely devoted to Dr. Arthur Dendy's very interesting memoir on the development of the Tuatara (*Sphenodon punctatus*).

MESSRS. WILLIAMS AND NORGATE have just issued No. 70 of their Book Circular (Scientific Series), in which is to be found notes on, and the titles of, numerous new and forthcoming publications in all branches of science.

WE are glad to learn that owing to the fact that the circulation of *Science Abstracts* now exceeds 4000 copies monthly, the price is to be reduced from three to two shillings per copy. Mr. W. R. Cooper has been promoted from assistant editor to editor, and the *Abstracts* are now published by Messrs. E. and F. N. Spon.

THE *Journal of Applied Microscopy*, published monthly by the Bausch and Lomb Optical Company, Rochester, N.Y., has now entered on the second year of its existence, and continues to supply useful practical notes to microscopists on microtechnique, the preparation of microscopical objects, and other kindred subjects.

FROM the Michigan State Agricultural College, we have received *Bulletins* Nos. 164 and 165 of the Farm Department:—Methods and results of tillage, and draft of farm implements, by M. W. Fulton; also *Bulletins* Nos. 5 and 6 of the Botanical Department:—Branches of sugar-maple and beech as seen in winter; and potatoes, ruta-bagas, and onions, by W. J. Beal.

SOME hydroids collected in Puget Sound are described and illustrated by Mr. G. N. Calkins in the *Proceedings* of the Boston Society of Natural History. The area examined was comparatively small, two points—Port Townsend and Bremerton—being the only localities represented in the collection. These two places, however, yielded no less than thirty species, a fact which promises well for the further investigation at different points on the Sound.

AN addition (No. 24) to the series of "Museum Handbooks," published in connection with the Museum of Owens College, Manchester, has been made by the publication of reprints from the *Journal of Conchology* of papers by Messrs. J. Cosmo Melville and Robert Standen, on the marine mollusca of Madras, and on marine shells from Lively Island, Falklands. This handbook is illustrated by two plates, one of which consists of a photographic reproduction of *Trophon geversianus*, from a specimen in the possession of Mr. Cosmo Melville.

LORD DELAMERE, during his recent expedition into East Equatorial Africa, made a valuable collection of zoological specimens, some of which he is presenting to the Natural History Museum. He succeeded in taking a series of photographs of most of the representative animals met with, including elephants, giraffes, zebras, antelopes, gazelles, &c. As the pictures show the characters of the country as well as the natural features and positions of the animals in their wild state, they are of scientific interest. They will be included in a volume entitled "Great and Small Game of Africa," to be published shortly by Mr. Rowland Ward.

IN the February number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* is an interesting summary by Prof. Grehant of his researches on the products of combustion of lighting gas under different conditions. He has specially studied the formation of carbon monoxide, on account of the deleterious action upon the health of small traces of this poisonous gas. Two methods were independently employed for this purpose, one physiological, depending upon the analysis of the gas extracted from the blood of animals who had been breathing the vitiated air, and the other purely chemical, depending upon the reduction of iodic anhydride at

150° C. by traces of carbon monoxide. In an ordinary batswing burner, the amounts of carbon monoxide found were so small as to be possibly due to experimental error, and in any case negligible. The ordinary incandescent burner gives off traces of this gas, and in fact whenever a gas flame strikes an obstacle within a certain distance of the orifice through which the gas is issuing, small quantities of carbon monoxide are evolved, and on this account special attention to the upward draught in all gas stoves is essential. No lighting burner in ordinary use appears to give off sufficient carbon monoxide to render any special precautions necessary, the author pointing out that more of this gas will be introduced into a room through slightly defective gas fittings than is given out by any pattern of burner in ordinary use.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. W. White; two Great Bats (*Vespertilio noctula*), British, presented by Mr. E. Hilton; a Common Seal (*Phoca vitulina*) from the River Spay, Scotland, presented by his Grace the Duke of Richmond and Gordon, K.G.; a Common Hare (*Lepus europaeus*), British, presented by Miss Henrietta Holland; an Egyptian Jerboa (*Dipus aegyptius*) from North Africa, presented by Mr. F. Tomlin; a West African Love Bird (*Agapornis pullaria*) from West Africa, presented by Mr. C. W. Gameys; a Kiang (*Equus hemionus*) from Tibet, a Rose-crested Cockatoo (*Cacatua moluccensus*) from Moluccas, an Echidna (*Echidna hystrix*) from New South Wales, deposited; a Cabot's Tragopan (*Ceriornis caboti*) from China, five Crested Colins (*Eupsychortyx cristata*) from Mexico, purchased.

OUR ASTRONOMICAL COLUMN.

COMET 1899 *a* (SWIFT).—The number of observations of this comet has been sufficient to allow of the orbit being computed, and for this the following elements are found:—

$$T = 1899, \text{ April } 13{\cdot}26, \text{ G.M.T.}$$

$$\left.\begin{aligned} \omega &= 4^\circ\ 54' \\ \Omega &= 23\ \ \ 9 \\ i &= 146\ \ \ 4 \\ q &= 0{\cdot}3447 \end{aligned}\right\} 1899$$

Ephemeris for 12h. G.M.T.

1899.		R.A. h. m.		Decl. ° ′		Br.
Mar. 16	..	2 56	...	11 53	...	1·00
17	...	2 52	..	−10 47	...	1·13
19	...	2 46	...	8 47		
20	...	2 43	...	7 55		
21	...	2 40	...	6 54	...	1·23
23	...	2 34	...	5 7		

The comet is brightening as it approaches the sun, and its rapidly decreasing southerly declination will render its observation more likely in these latitudes. It is said to be round, with a diameter of about 7′ of arc, having a central condensation and a short tail. It should be looked for immediately after sunset near η Eridani, and will move from that position towards the variable star o Ceti (Mira).

TUTTLE'S COMET 1896 *b*.—In *Ast. Nach.*, 3552, Mr. J. Rahts gives an improved ephemeris of this comet, together with the elements.

1899.		R.A. h. m.		Decl. ° ′
March 17	...	2 2	...	+28 49
21	...	2 18	...	27 42
25	...	2 33	...	26 30
29	...	2 48	...	+25 13

The comet is increasing in brightness.

NEW STAR IN AQUILA.—A circular from the Centralstelle at Kiel informs us of the present state of the new star discovered by Mrs. Fleming in March 1898, during the examination of the Harvard plates. The position of the star for epoch 1900 is R.A. = 18h. 56m. 13s.; Decl. = −13° 18′; this place is in the south-western border of Aquila, or on some charts in the north-west of Sagittarius. At the time of discovery the Nova was of the fifth magnitude, while now (March 10) Prof. Pickering gives it the magnitude ten, as determined from the photometric measurement of eight plates.

PHOTOGRAPHY OF CORONA.—For the past four or five years several astrophysicists have been attempting to obtain photographs of the Solar Corona without the aid of a total eclipse, but so far, however, without success. Sig. A. Ricco, director of the Catania Observatory, gives the history of the investigation as well as the results of his own attempts on the problem. [*Bulletin de la Soc.-Belgé d'Astronomie*, vol. iii. No. 4.] The first attempts described are those of Dr. Huggins, who employed a reflector having an extended cap provided with numerous diaphragms to minimise the amount of scattered light. A similar apparatus has also been used by A. Mascari at the observatory on Mount Etna. Certain corona-like forms do appear on the photographs thus obtained, but there seems to be no probability of their being real.

Later Prof. G. E. Hale, using a spectroheliograph at Mount Etna, attempted to photograph the corona by isolating the violet calcium line (K) of the spectrum, and traversing the sun's image given by a lens across the slit of the instrument. This was also unsuccessful.

Prof. Ricco then tried using a portrait lens, but with no better result; and the last attempts he describes were made with pin-hole cameras of various dimensions, these also failing to record any true image. Reproductions of the photographs obtained with all four types of apparatus are given, and examination of these shows that the only appearance photographed is the graduated halation effect radiating equally in all directions from the solar disc.

HARVARD COLLEGE OBSERVATORY.—In the Harvard College Observatory *Circular*, No. 39, Prof. E. C. Pickering presents some remarks on the work done with the new Bruce photographic doublet in comparison with other instruments of different design. He advocates that in future new large telescopes should be made of widely-varying types, so that the most appropriate form for any particular department of astronomical work may be obtained. The Bruce telescope was a new departure from conventional lines, and its complete success encourages the extension of the inquiry. In this case the instrument has a very short focal length, and Prof. Pickering proposes, if funds be forthcoming, to design an instrument of unusually long focus, say from 130 to 160 feet, with an aperture of from 12 to 14 inches. This he would place horizontally, and feed with light from a mirror. The diurnal motion would be counteracted by moving the plate by clockwork, as in the horizontal photoheliograph now in use at Cambridge. With such an instrument he thinks much could be done in obtaining better photographs of the solar surface and the prominences; pictures of the moon could be got exceeding 12 inches in diameter without enlargement, and possibly photographs of the planets Jupiter, Saturn and Mars. It would also be useful in re-determining the solar parallax from the next approach of Eros in 1900, by observing the planet east and west of the meridian.

Circular No. 40 gives a description of the methods adopted at the observatory for photographing meteors. In the case of determining the radiant point of bright meteors the usual method of intersecting trails is scarcely applicable, their number being so small. If, however, the meteor is simultaneously observed from *two* stations, the radiant can be determined just as correctly. Provision for this has been made, cameras provided with automatic exposing shutters having been installed at Blue Hill and Cambridge. The lenses are of wide angle, and point to the zenith. If two photographs of the same meteor are superimposed, the height at the instant of exposure can be found by a simple proportion. As the distance of the meteor on the two photographs is to the focal length of the lenses, so is the distance apart of the two stations to the required altitude. The positions of the trails in space can be found if stars are also photographed on the plates, the intersection of the two trails giving the declination of the radiant point of the meteor. The right ascension is, however, indeterminate unless time of appearance is known, or, as may be later, the camera be mounted equatorially.

The value of placing a prism in front of the lens to obtain spectra is also mentioned, and it is recommended that the plate be kept in vibration at a known rate. Prof. Pickering thinks that using three plates each night it would be possible to determine the altitude, radiant point, velocity and spectrum of one-third of all the bright meteors visible in any locality.

FORTHCOMING BOOKS OF SCIENCE.

Mr. Félix Alcan (Paris) promises:—(Bibliothèque Scientifique Internationale "La géologie expérimentale," by Prof. Stanislas Meunier; "La Nature tropicale," by J. Constantin. Médicine.—"Chirurgie de la plèvre," by Prof. Terrier and Dr. Reymond, illustrated; "Chirurgie d'urgence," by Dr. Cornet, illustrated; "L'Instinct sexuel, evolution," by Dr. Ch. Féré, illustrated; "Traité d'histologie pathologique," by MM. Cornil, Brault and Letulle, 3 vols., illustrated; "La profession médicale (Devoirs et Droits), by Prof. Morache; "La mécanothérapie," by Dr. F. Lagrange; "Etudes de chirurgie médullaire," by A. Chipault, Tome i. and ii., illustrated.

Mr. Edward Arnold announces:—"Dynamics for Engineering Students," by Prof. W. E. Dalby; "Elementary Natural Philosophy," by A. Earl; "An Elementary Chemistry," by W. A. Shenstone, F.R.S.; "Physical Chemistry," by Dr. Alexander Scott; "A Manual of Physiology," by Dr. Leonard Hill; "A Manual of Botany," by David Houston; "A Manual of Physiography," by Andrew J. Herbertson; "Wood: its Natural History and Industrial Applications," by Prof. G. S. Boulger.

Messrs. Baillière, Tindall, and Cox give notice of:—The Harben Lectures, 1898–99: "The Administrative Control of Tuberculosis," by Sir Richard Thorne Thorne, K.C.B.; "Arris and Gale Lecture, Royal College of Surgeons of England, 1899," by Dr. B. G. A. Moynihan; "The Analysis of Food and Drugs," by T. H. Pearmain and C. G. Moor, part ii., "The Chemical and Biological Examination of Water"; "The Pocket Pharmacopœia: including the Therapeutical Action of the Drugs with the Natural Order and Active Principle of those of Vegetable Origin," by F. Hudson-Cox and Dr. John Stokes; "Dictionary of Medical Terms," by H. de Méric, part ii., French-English; "Aids to Materia Medica," by Dr. W. Murrell, part ii.

Messrs. A. and C. Black's list contains:—"Human Geography," by A. J. Herbertson; "Physics," by A. T. Walden and J. J. Manley.

Messrs. Gebruder Borntraeger (Berlin) give notice of:—"Symbolae Antillanae seu Fundamenta Florae Indiae Occidentalis," edited by Urban, vol. i., Fasc. i; "Werden und Vergehen," by Carus Sterne.

The list of Messrs. C. J. Clay and Sons (Cambridge University Press) includes:—"Collected Mathematical Papers," by Prof. P. G. Tait, vol. ii.; "The Scientific Papers of John Couch Adams," vol. ii., edited by Prof. W. G. Adams and R. A. Sampson; "Scientific Papers," by Lord Rayleigh, F.R.S.; "Scientific Papers," by the late Dr. Hopkinson, F.R.S.; "Scientific Papers," by Prof. Osborne Reynolds, F.R.S.; "The Strength of Materials," by Prof. J. A. Ewing, F.R.S.: "A Treatise on Spherical Astronomy," by Prof. Sir Robert S. Ball, F.R.S.; "A Treatise on Geometrical Optics," by R. A. Herman; "On the Kinetic Theory of Gases," by S. H. Burbury, F.R.S.; "Zoological Results based on material from New Britain, New Guinea, Loyalty Islands, and elsewhere, collected during the years 1895, 1896 and 1897," by Dr. Arthur Willey, part iii., illustrated; "Fauna Hawaiiensis," or the Zoology of the Sandwich Islands, being results of the explorations instituted by the Joint Committee appointed by the Royal Society of London for Promoting Natural Knowledge and the British Association for the Advancement of Science, and carried on with the assistance of those bodies and of the Trustees of the Bernice Pauahi Bishop Museum," edited by Dr. David Sharp, F.R.S., vol. i. part i.: *Hymenoptera Aculeata*, by R. C. L. Perkins; Cambridge Natural Science Manuals (Biological Series): "Fossil Plants," a manual for students of botany and geology, by A. C. Seward, F.R.S., vol. ii.; "The Soluble Ferments and Fermentation," by Prof. J. Reynolds Green, F.R.S; (Physical Series): "Electricity and Magnetism," by R. T. Glazebrook, F.R.S; "Sound," by J. W. Capstick; (Geological Series), Crystallography, by Prof. W. J. Lewis; (Cambridge Geographical Series), "Man, Past and Present," by A. H. Keane; "Military Geography," by Dr. T. Miller Maguire.

Messrs. Georges Carré and C. Naud (Paris) announce:—"Matière Médicale Zoologique," by Prof. Henri Beauregard, illustrated; "Travaux Pratiques de Physiologie," by Prof. R. Dubois; "Résistance des Matériaux," by Prof. M. Duplaix, illustrated; "La Photothérapie," by N. R. Finsen, illustrated; "Leçons sur la Morphologie des Insectes," by L. F. Henneguy, illustrated; "Les Sanatoria Traitement et prophylaxie de la phtisie pulmonaire," by S. A. Knopf, illustrated; "Les Concours agricoles," by H. Marchand; "Cours de Géométrie élémentaire," by B. Niewenglowski and L. Gérard; "Distillation et Rectification des Alcools, by G. Sorel, illustrated; "L'éclairage à incandescence par le gaz et les liquides gazéifiés," by P. Truchot.

Messrs. Cassell and Co., Ltd., promise a new and revised edition of "Optics," by Profs. Galbraith and Haughton, and an enlarged issue of "Familiar Wild Flowers," by F. E. Hulme.

Messrs. J. and A. Churchill's list includes:—"A Text-book of Physics," by Prof. Andrew Gray, F.R.S., in three parts, illustrated; "Materia Medica," by Prof. H. G. Greenish, illustrated; and new editions of "Allen's Commercial Organic Analysis," vol. ii. part 2, and vol. iii. part 1.

Messrs. J. M. Dent and Co.'s announcements contain:—"Insects," by Dr. Carpenter.

Messrs. Duckworth and Co. give notice of:—"A Glossary of Botanic Terms," by B Daydon Jackson; "A Text-book of Agricultural Botany, Theoretical and Practical," by Prof. John Percival; "A Text-book of Plant Diseases caused by Cryptogamic Parasites," by George Massee.

Mr. W. Engelmann (Leipzic) announces:—"Geschichte der physikalischen Experimentirkunst," by Prof. E. Gerland and Prof. F. Traumüller, illustrated; "Die optischen Instrumente der Firma," by R. Fuess, illustrated; "Grundzüge der Pflanzenverbreitung in den Kankasusländem," by Dr. Gustav Radde.

In the list of Messrs. R. Friedländer and Son (Berlin) we find:—C. Clusius, "Icones Fungorum in Pannoniis," by Prof. Gy. de Istvánffi, Fasc. ii.; Gerberti, "Opera Mathematica," collected and edited by N. M. Bubnow; "Das Tierreich," Lieferung 5: Sporozoa, by Dr. A. Labbé; Lieferung 7: Sarcoptidae and Demodicidae, by Prof. G. Canestrini and Prof. P. Kramer; Leiferung 8: Pedipalpi et Scorpioninae, by Prof. K. Kraepelin; Trochilidae, by E. Hartert; Hydrachnidae and Halacaridae, by R. Piersig and Dr. H. Lohmann; Catalogus Mammalium tam viventium quam fossilium, by Dr. E. L. Trouessart, Fasc. vi., Addenda et Corrigenda, Index alphabeticus.

Mr. Henry Frowde announces:—"Annals of Botany," No. xlix.; Goebel's "Organographie der Pflanzen," translated by Prof. I. Bayley Balfour, F.R.S.; Pfefler's "Pflanzenphysiologie," translated by Dr. A. G. Ewart.

Messrs. Gauthier-Villars et Fils (Paris), promise:—"Electricité on des hertziennes Rayens X," by E. Bouty; "Excursion électrotechniche," by Prof. Janet; "Principes et pratique d'Art en Photographie," by Frédéric Dillaye, illustrated; "Histoire abregée de l'Astronomie," by Prof. E. Lebon, illustrated; "Répertoire universel de Bibliographie des Industries tinctoriales et des industries annexes," by J. Garçon; "Dix leçons de Photographie élémentaire," by Eug. Trutat; "L'Objectif photographique," by P. Moëssard, illustrated; "Traité pratique de Photogravure en relief et en creux," by Léon Vidal, illustrated.

The list of Sampson Low, Marston, and Co., Ltd., includes:—"Twentieth Century Practice, an International Encyclopædia of Modern Medical Science by Leading Authorities of Europe and America," edited by Thomas L. Stedman, vols. xvi., xvii., xviii., xix., xx.

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The list of Messrs. Macmillan and Co., Ltd., includes:—"The Scientific Memoirs of Thomas Henry Huxley," edited by Prof. Michael Foster, F.R.S., and by Prof. E. Ray Lankester,

F.R.S., in four volumes, vol. ii.; "The Steam Engine and Gas and Oil Engines," by Prof. John Perry, F.R.S., illustrated; "A System of Medicine," by many writers, edited by Dr. Thomas Clifford Allbutt, F.R.S., vols. vi., vii., and viii.; "Dictionary of Political Economy," edited by R. H. Inglis Palgrave, F.R.S., vol. iii. (completing the Dictionary); "Elementary Physics and Chemistry, First Stage, by Prof. R. A. Gregory and A. T. Simmons.

Mr. Murray calls attention to:—The Progressive Science Series: "On Whales," by F. E. Beddard, F.R.S., illustrated; "The Stars," by Prof. Newcomb, illustrated; "Man and the Higher Apes," by Dr. Keith, illustrated; "Heredity," by J. Arthur Thomson, illustrated; "Bacteriology," by Dr. G. Newman, illustrated.

In the list of Messrs. Kegan Paul and Co., Ltd., we find:—"The Geography of Mammals," by Dr. P. L. Sclater, F.R.S., illustrated; "Experimental Physics," by the late Prof. von Lommel, translated by Prof. G. W. Myers, illustrated; "Sewage Analysis," by J. A. Wanklyn and W. J. Cooper.

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The list of Messrs. Swan Sonnenschein and Co., Ltd., contains:—"Physiological Psychology," by Prof. W. Wundt, translated by Prof. E. B. Titchener, 2 vols., illustrated; "Text-book of Palæontology for Zoological Students," by Theodore T. Groom, illustrated; "Text-book of Embryology: Invertebrates," by Dr. E. Korschelt and Dr. K. Heider, translated from the German by Mrs. H. M. Bernard, and edited (with additions) by Martin J. Woodward, vols. ii. and iii., illustrated; "The Phenomena of Nature," by J. Walker, part ii.; "Mammalia," by the Rev. H. A. Macpherson (Young Collector Series); "Birds' Eggs and Nests," by W. C. J. Ruskin Butterfield (Young Collector Series); and new editions of "Handbook of Practical Botany," by Prof. E. Strasburger, edited by Prof. W. Hillhouse, illustrated; "Text-book of Embryology: Man and Mammals," by Dr. O. Hertwig, translated by Dr. E. L. Mark; "The Elements of Vital Statistics," by Dr. Arthur Newsholme, illustrated; "An Introduction to the Study of Zoology," by B. Lindsay, illustrated (Introductory Science Text-books).

Mr. T. Fisher Unwin gives notice of:—"The Climbs of Norman Neruda," by Mrs. Norman Neruda, illustrated; "The Kingdom of the Ba-Rotsi—Upper Zambesia," by Alfred Bertrand, translated by A. B. Miall, illustrated; "Claude Bernard," by Prof. Michael Foster, F.R.S. (vol. vi. "Masters of Medicine" Series).

Messrs. Whittaker and Co.'s announcements are:—"Outlines of Physical Chemistry," by Prof. A. Reychler, translated from the French by Dr. J. McCrae; "Volumetric Chemical Analysis," by J. B. Coppock; "Central Station Electricity Supply," by A. Gay and C. H. Yeaman; "Electric Wiring, Fittings, Switches and Lamps," by W. Perren Maycock; "Electric Traction," by J. H. Rider; "Inspection of Railway Material," by G. R. Bodmer; "English and American Lathes," by Joseph Horner.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 199th meeting of the Junior Scientific Club took place on Friday evening, March 10, at the Museum. In private business the officers for next term were elected, and there was a long debate on a motion of Mr. A. E. Boycott (Oriel) to confine the ordinary membership of the Club to members of the two Universities of Oxford and Cambridge and to persons engaged in scientific work in Oxford in connection with the University. Ultimately the amendment of Mr. A. F. Walden (New College) to delete the words "in connection with the University" was carried by a large majority, and the amended motion passed. In public business, Mr. F. W. Charlton (Merton) read a paper on "Gold mining," and Mr. A. F. Walden a paper "On the condition of dissolved substances in solutions other than aqueous."

The Robert Boyle Lecture of 1899 will be delivered in Eight's week of next term, by Prof. E. Ray Lankester, F.R.S.

CAMBRIDGE.—The grace for the establishment of a professorship of Agriculture will be offered to the Senate on May 11.

The researches in magnetism and electricity, presented by Mr. S. W. Richardson and Mr. J. Henry, advanced students of Trinity College, have been approved by the special Board for Physics as qualifying for the B.A. degree.

Mr. T. Andrews, F.R.S., has presented a valuable metallurgical microscope to the engineering laboratory.

The degree of M.A. *honoris causa* has been conferred on Dr. G. Sims Woodhead, Professor of Pathology.

Profs. Thomson, Forsyth, and Macalister, and Mr. F. Darwin have been appointed electors to the Allen Studentship for original research recently founded in the University.

IT appears from a useful table published in the *Library World* for February, that 363 towns and districts of the United Kingdom have adopted the Public Libraries Act. The progress of the movement was slow while the power of adoption remained in the hands of the ratepayers; but since it was transferred, in 1893, to the option of town councils and other authorities, the rate of progress has increased nearly threefold. Between 1850 and 1892, 256 places had adopted the Act—an annual average of about 6; but in the six years from 1893 to 1898, 107 places had established libraries—a yearly average of 16, excluding London, which still retains the public vote.

THE names of the present curators of patronage, by whom the appointment of a professor of physiology in the University of Edinburgh, in succession to the late Dr. Rutherford, are given by the *British Medical Journal* as follows:—Principal Sir William Muir, the Right Hon. J. P. B. Robertson, Lord Justice-General for Scotland; and Dr. Patrick Heron Watson, elected by the University Court, while the following four curators are elected by the Town Council; the Right Hon. Lord Provost Mitchell Thomson, Lieut.-Colonel Alexander Forbes MacKay, Sir James Alexander Russell, and Mr. George Auldjo Jamieson. It is stated that already the following gentlemen are candidates for the vacant chair: Prof. E A. Schäfer, F.R.S., Dr. William Stirling, Dr. Diarmid Noel Paton, Dr. E. Waymouth Reid, F.R.S, and Dr. E W. Wace Carlier, senior assistant to the late Prof. Rutherford. Dr. Carlier is at present giving the lectures in physiology in the University. The emoluments of the chair will in future be of the annual value of 1400*l*.

A GEODETIC observatory is a necessary part of the equipment of an institution giving instruction in geodetic methods of surveying. Such an observatory has lately been established in connection with the Massachusetts Institute of Technology. This observatory is intended primarily to be used in giving instruction in the most refined methods of determining latitude and longitude, and is also to be used in magnetic and gravity observations. A hill in the south-eastern part of Middlesex Fells was chosen for the site. Here was found a firm foundation for the most delicate instruments, free from the vibrations caused by railroad and highway traffic, and not too far from Boston. Much work has been done at the observatory that could not before be performed in any of the Institute buildings. This is especially true of the tests on delicate spirit-levels and the determination of constants depending on such observations. This is due to the freedom of the observatory from vibrations, while its distance from all magnetic disturbances renders it especially favourable for observation with the magnetometer and dip circle. It has been attempted to give the students in geodesy such practice as will not only illustrate the theory, but enable them to make satisfactory observations of paramount value with all the various instruments employed. The observatory will also be used by all civil engineering students in connection with their fourth year astronomy. The observatory, on account of its good position, will be a valuable magnetic station, and its observations will probably be incorporated in the general magnetic work of the United States Government.

IN the House of Lords on Tuesday, the Duke of Devonshire called attention to the subject of secondary education, and introduced a Bill dealing with it. The *Times* reports him to have said, in the course of his remarks, that by the Bill it is proposed to constitute a Board of Education of the same

character as the Board of Trade or the Board of Agriculture. Like the Board of Trade, and unlike the Board of Agriculture, the new department will have a Parliamentary secretary as well as a president; but the office of vice-president will cease to exist, although the present vice-president will continue to be a member of the Board. The Bill will give more elastic powers for the transfer of the educational functions of the Charity Commissioners to the new department. At first there will only be such an inspection and examination of local schools as will bring the endowed, municipal, private, and proprietary schools within their areas to some common local scheme. It is intended that the inspection shall be optional, except in the case of schools which are being conducted under schemes framed by the Endowed Schools Commissioners. In the first instance, no attempt will be made to impose upon the schools anything like uniformity in their course of instruction, but the inspection will be made in accordance with the advice given by the consultative committee. It is considered that the registers of teachers, both in elementary and secondary schools, may be most properly kept by the Department itself; but it is provided that the regulations relating to the registers shall be framed in accordance with the advice given by the consultative committee. The composition of that committee will not be stereotyped by the terms of the Bill, which provides, however, that two-thirds of the members shall be representatives of the Universities or of other teaching bodies. The organisation of the Science and Art Department will be revised, and the task will be undertaken by a departmental committee, which will be appointed as soon as the principle of the amalgamation of this Department with the Education Department has been approved by Parliament. The inquiry will occupy a considerable amount of time, and it is, therefore, proposed that the present Bill shall not come into force until April 1 next year.—The Bill was read for a first time.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 23.—"Deposition of Barium Sulphate as a Cementing Material of Sandstone." By Frank Clowes, D.Sc., Emeritus Professor, University College, Nottingham. Communicated by Prof. H. E. Armstrong, F.R.S.

Some years ago the author described the occurrence of a peculiar sandstone over a large area in Bramcote and Stapleford, near Nottingham (*Roy. Soc. Proc.*, vol. xlvi. p. 363). The sandstone was remarkable for its high specific gravity; and chemical analysis, supported by microscopical examination, proved that the high specific gravity was due to the existence in the sandstone of a large proportion of highly crystalline barium sulphate. In the rock itself the percentage of the sulphate varied from 33·3 to 50·1; and it evidently served as the binding or cementing material which held the sand grains together. The occurrence of this sandstone was stated by geologists to be unique in the United Kingdom.

Mr. J. J. H. Teall made an examination of the sandstone, and, after breaking up a portion of the rock, found that the small cleavage flakes gave the optical characters of crystallised barium sulphate. Mr. Teall further stated that the barium sulphate occurred in large irregular crystalline patches, which included the sand grains.

The author noted that in some parts of the rock the sulphate occurred in reticulated veins enclosing small patches of more or less loose sand grains; while in other parts of the rock the sulphate occurred in spherical or oval masses, between which looser sand was interspersed; occasionally, however, the barium sulphate was uniformly distributed.

The appearance presented by the weathered surface of the rock varied according to the mode in which the resistant sulphate was distributed. When it was uniformly distributed, it formed an almost complete protection against weathering: the reticulated distribution of the sulphate caused the surface of the weathered rock to present a fretted surface, with the thin veins of sulphate projecting from the surface; while when the sulphate had bound together spherical or oval masses in the substance of the sand, these were left in pebble-like forms as soon as the loose sand had been washed out from between them.

Dr. Bedson had shown (*J.S.C.I.*, vol. vi. p. 712) that barium chloride was present to the extent of 137·2 parts per 100,000 in some of the colliery waters of the Durham coal-field, and the ferrous sulphate and sulphuric acid derived from the iron pyrites in the beds of coal and shale caused the frequent deposition of barium sulphate from such water. The author of the present paper described some of these deposits (*Roy. Soc. Proc.*, June 1889), and suggested that the calcium sulphate present in the waters of the Nottingham district would in a similar way cause barium sulphate deposits from barium chloride spring water. But in the Nottingham district all evidence of barium chloride in solution was wanting.

Such a barium chloride water, derived from an artesian boring at Ilkeston, has recently been found by Mr. John White (*The Analyst*, February 1899). The Ilkeston boring has been made in the immediate neighbourhood of the Bramcote and Stapleford sandstone which contains the large proportion of barium sulphate. Since the barium chloride is found to the extent of 40·7 parts per 100,000 in the water from this boring, and seems to be a normal constituent of the water, it would appear that soluble barium salts are present in the district, and may therefore have given rise to the deposition of the barium sulphate in the original sand beds. The crystallisation of the sulphate around the sand grains would then cause it to act as a compact, insoluble cementing material.

Since the publication of his original paper on the occurrence of barium sulphate in the Bramcote sandstone, the author has continued his examination of samples of sandstone from the basement of the pebble beds of the Bunter, with the object of ascertaining whether the occurrence of barium, either as sulphate or in other forms of combination, was characteristic of the sandstones of that geological period. He had thus far failed to find any similar rock to that at Bramcote, and it therefore seems probable that the occurrence of barium sulphate, although it extends over a very extensive area at Bramcote and Stapleford, must be looked upon as being due to purely local causes. Such local causes, however, appear to have occurred in certain other districts, since Messrs. J. Lomas and C. C. Moore stated to the Liverpool Geological Society, on February 8, 1898, that large proportions of crystallised barium sulphate occurred in triassic sandstones at Prenton and Bidston. In different specimens of the sandstone the percentage of the sulphate varied from 12·4 to 33·8 per cent. It was described as being colourless and highly crystalline, and adherent to the sand grains in such a way as to show that it has been deposited *in situ* subsequently to the sand grains. Mr. Lomas stated that the occurrence of barytes in the trias was fairly common, and mentioned the following localities, in which its presence is well known: Beeston, Alderley Edge, Oxton, Storeton, and Peakstones Rock, Alton.

"Some Experiments bearing on the Theory of Voltaic Action." By J. Brown. Communicated by Prof. Everett, F.R.S.

The experiments were intended to test the theory which attributes the difference of potential observed near metals in contact to the chemical action of films condensed on their surfaces, from the atmosphere or gas in which they are immersed, by investigating the effect of removing the chemically active matters from this atmosphere. On the hypotheses the difference of potential should be reduced thereby to zero, and regain a value near its original, when air was re-admitted. Previous experimenters had not found this to be the case, but it was hoped that elaborate precautions in details might give more definite results than had been hitherto obtained.

A copper-zinc volta condenser with plates 101 mm. by 47 mm. was sealed up in a glass tube in an atmosphere of nitrogen exhausted to a few millimetres pressure, together with metallic potassium and sodium, to absorb any oxygen or other chemically active matters that might have remained in the nitrogen. The zinc plate of the condenser was carried on a glass support hinged to a prolongation of the copper plate, so that on tilting the tube the plates could be separated, in order to measure the difference of potential by a well known zero method. Platinum wires sealed into the tube made connections for this purpose. Three experiments were made.

In No. 1, lasting six months, the difference of potential fell gradually from 0·74 volt at starting to 0·33 volt. On admitting air it rose to 0·48 volt.

In No. 2, lasting eighteen months, the fall was from 0·7 volt to 0·52 volt, and on opening the tube this value did not sensibly change. The fall was therefore probably due to the well-known effect of tarnishing of the zinc surface.

In No. 3, potassium and sodium were fused together to form the alloy liquid at ordinary temperatures. The difference of potential was 0·75 volt at starting, and fell in the course of seven and a half years to 0·49 volt. On opening the tube there was little appreciable change in this value. The fall in this case also was therefore no doubt due to tarnishing of the zinc surface.

Experiment 1 is the only one of the three which lends some degree of support to the hypothesis which, however, from evidence in other directions, seems nevertheless to be the true theory. If so, the negative results here obtained are no doubt due to the difficulty of removing the last traces of active matter from the gas employed.

Experiments by C. Christiansen (*Wied. Ann.*, vol. lvi. p. 644), confirm this view. He shows that, if the metals be exposed for only a minute fraction of a second in hydrogen the difference of potential is very much lower than when the exposure is continuous in air. Here the active matters have not time to diffuse through the hydrogen to the metal in sufficient quantity to produce the full effect.

Physical Society, March 10.—Prof. Oliver Lodge, F.R.S., President, in the chair.—Mr. A. A. Campbell Swinton described and exhibited the Wehnelt current-interrupter. A glass cell contains a large cylindrical negative electrode of lead, and a small positive electrode consisting of a platinum wire about 1/16 inch or ⅜ inch in length, in a solution of one part sulphuric acid to about five parts water. The platinum wire may project from the top of the shorter arm of a **J**-shaped ebonite tube, so that it can point upwards immersed in the solution. Or it may be fused into a similar glass tube; but glass is apt to crack in the subsequent heating. Wehnelt's interrupter replaces the make-and-break apparatus of an induction coil; it also replaces the ordinary condenser of that apparatus. In its present form it requires rather a strong current. The resulting spark at the secondary terminals differs in character from the ordinary spark of an induction coil: it is almost unidirectional, and in air takes a **V**-form, bright, continuous, and inverted—somewhat like a pair of flaming swords rapidly crossing and recrossing one another at their points. By blowing upon the **V** it breaks up, and then more nearly resembles the customary discharge of a coil. The sound emitted by the spark has a pitch that varies with the conditions of the circuit. As the self-induction of the circuit is diminished, the spark-pitch rises; it becomes infinite when the self-induction vanishes, *i.e.* the Wehnelt interrupter will not work in a circuit devoid of self-induction. As the applied potential-difference diminishes, the spark-pitch diminishes. In Mr. Campbell Swinton's experiments, twenty-five volts was the minimum primary voltage at which his apparatus would work. The spark-pitch also varies with the length of the platinum wire electrode in the solution. If the circuit is closed by dipping this electrode into the solution, the apparatus will not work; the wire must be dipped in before closing the circuit. After working for about a quarter of an hour the action often ceases; this fatigue-effect is not due to heating of the solution, for it is not obviated by keeping the temperature constant by a water-bath. It is supposed that the oxygen generated at the platinum electrode forms a more or less insulating film which interrupts the current until absorbed by the surrounding water. The fact that oxygen is more easily absorbed than hydrogen may explain why it is necessary to connect the platinum electrode to the positive pole of the battery or dynamo. When the platinum electrode is dipped gradually into the solution, the wire gets red-hot, and the interruptions do not take place. Again, when the apparatus stops, from fatigue, the platinum gets red-hot. The action is further complicated by a series of small explosions, and by the formation of a kind of electric arc at the platinum electrode. The coil exhibited was connected to the 100-volt electric-light mains at Burlington House; in this case the potential difference at the terminals of the primary was 30 volts, and that across the interrupter 150 volts—a total of 180 volts, showing the effect of impedance. For Röntgen-ray work the apparatus would be very effective, but unfortunately the sparks produce great heating, so that the kathodes of tubes are melted. Mr. Campbell Swinton suggested that as the sparks were more nearly continuous than ordinary discharges, they might produce Hertz waves less rapidly attenuated than those now applied to wireless telegraphy; the trains of waves would also follow one another at shorter intervals than those from the sparks at present employed. The President said he was rather surprised that the self-induction of the primary coil was not sufficient of itself to form the induction factor in the impedance necessary for perfect working. He would like to know how the apparatus behaved when an alternating current was used. Did the secondary coil become damaged by over-heating? Did reversal of the current assist the recovery from the fatigued condition of the apparatus? The natural period of the circuit depended upon its capacity and its self-induction. There was undoubtedly capacity at the surface of the platinum electrode in the liquid; this capacity acted together with the auxiliary self-induction, and the self-induction of the rest of the circuit, in the orthodox way, and there was automatic adjustment of resonance to the frequency of the interruptions, probably by variations of the capacity at the electrode. The heating effect, when a wire was made to close a circuit with a liquid, was discovered many years ago. Prof. G. M. Minchin thought that the usefulness of the apparatus would be greatly increased if it could be made to work with less current. He had himself succeeded with 12 applied volts, but not with 10 volts. As a tentative experiment he had used a horizontal lead plate, with disastrous effect, for the apparatus went suddenly to pieces. Explosions were frequently obtained, but they were not attended with much real danger. In a later and safer apparatus he used a platinum wire about ¾ inch long, projecting from a glass tube around which the lead plate was bent. There appeared to be a definite depth of immersion of this wire, at which the apparatus worked with minimum current. In his apparatus this critical position was when half the wire was below the surface of the liquid, the other half projecting into the air. He attributed the fatigue to the presence of gas about the electrodes, for he observed that a mechanical tap to the base of the apparatus restored the working condition. Mr. Rollo Appleyard pointed out that the improved result at half immersion, observed by Prof. Minchin, taken together with the phenomena described by Mr. Campbell Swinton as to the effect of dipping the electrodes into the solution, suggested that the liquid immediately around the submerged part of the wire was at some instants in the spheroidal state. The breaking-down of the spheroidal state would be facilitated by heat lost by the immersed part to the non-immersed part of the wire. The capacity for heat of the non-immersed part, and the degree of roughness or smoothness of the immersed part, would thus appear as factors in the explanation. No doubt the evolved gases were the primary cause of the interruption of current, but the wire having once become red-hot the spheroidal condition would introduce a further cause of electrical separation between the wire and the liquid. Prof. Vernon Boys asked whether it was the liquid or the electrodes that became fatigued. Experiments should be made to determine the effect of variations in the hydrostatic pressure around the platinum electrode. Mr. T. H. Blakesley said that the rise of potential at the terminals of the interrupter proved that the arrangement possessed capacity. Such a rise of potential could not occur without there being capacity, any more than it could without self-induction. Mr. D. K. Morris described experiments he had made with a Wehnelt interrupter, using a 1 kilowatt transformer with a transformation of 4 to 5, intended for 10 amperes at 100 volts. The anode of the interrupter was designed to have an adjustable surface to correspond with the load on the secondary—a platinum wire at the end of a copper wire could be projected more or less through the drawn-out lower end of a glass tube containing oil. The best results with the interrupter were obtained with about 45 volts on the primary circuit. At this pressure, an average current of 1 ampere sufficed to give 125 (alternating) volts very steadily on the secondary. As measured by an electrostatic instrument, the "no-load" loss was only 45 watts. The secondary could then be loaded up with lamps, provided that the exposed surface of platinum wire was proportionately increased. The energy delivered to the lamps, however, was not at any load much greater than 45 per cent. of that taken from the mains. By connecting the interrupter with a condenser of ½ microfarad, the efficiency at small loads was increased to nearly 60 per cent. He had observed that the fatigue of the interrupter could be temporarily remedied by reversing the current. Mr. C. E. S. Phillips asked whether Mr. Campbell Swinton had tried other liquids than dilute sulphuric acid. So far as his own experiments went, he had only obtained good results with that electrolyte. Mr. Campbell Swinton, in reply, said that with the apparatus arranged in a simple circuit, an alternating current applied

to the primary of an induction coil through a Wehnelt interrupter produced only about half the effect of the corresponding direct current—apparently, only half the alternations got through. But if two interrupters were connected in parallel circuits it was possible so to arrange them that one took one-half and the other the second half of the alternations. It might, therefore, be possible to design an induction coil with two primary windings to correspond to the two interrupters, so as to give an additive effect. The induction coil he had used had suffered no damage from the currents employed in the experiments exhibited; there was extremely little heating of the secondary. He could not with his apparatus restore the working condition by any mechanical disturbance of the interrupter. Hydrochloric acid failed, but a saturated solution of potassic bichromate gave fair results. The President, in proposing thanks, said he did not agree with Mr. Campbell Swinton's remarks as to the chances of improving Hertzian telegraphy by the use of these interrupters. The rate of interruption with this apparatus was something like 1000 per second, but the vibrations corresponding to Hertz waves were of the order 100,000 per second. The wave-trains from oscillators excited by the new interrupter would still be a series of damped vibrations; the amplitudes would not be maintained. It might be advantageous to have sparks following one another so rapidly, but he doubted it. For Hertzian telegraphy, the spark at the oscillator should "crackle"; to produce the best effect, the air about the oscillator should be in a non-electric condition.—A paper by Mr. A. Griffiths, on an apparatus for the determination of the rate of diffusion of solids dissolved in liquids, was then read. The apparatus consists of a cylindrical glass vessel subdivided about midway by a horizontal non-porous partition, into which are fitted a number of vertical tubes. The lower section of the vessel is filled with a liquid, such as an aqueous solution of cupric sulphate, and the upper one contains pure water. The method consists in determining by chemical analysis the quantity of cupric sulphate transmitted up the tubes. The paper gives the theory of the method, with very few experimental results. Ordinary diffusion observations are affected by the flow of liquid in the tubes due (1) to changes of temperature of the apparatus as a whole; (2) to differences of temperature throughout the liquid; (3) to local variations in volume produced by the process of diffusion; (4) to inequalities in the lengths of the tubes. Equations are given for determining the magnitudes of the sources of error, and certain numerical cases are worked out.—The same author also contributed a note on the source of energy in diffusive convection. Diffusion tends to produce local changes of density, causing gravitational currents, which currents can be made to do work. By "diffusive convection," the author means these gravitational currents. The heat equivalent of the work done is determined in a particular case, *i.e.* for a subdivided vessel, as in the above paper, having two tubes of unequal length. He points out that the heat absorbed, owing to diffusion through one of the tubes, is independent of the mechanical motion of the liquid in that tube, and it is also independent of the length of the tube.—The President proposed a vote of thanks, and in doing so described an apparatus he had used for a thermostat. A double-walled cylinder of copper sheet, with a little water in the inter-space, is exhausted at atmospheric temperature until the water boils. It is then sealed. Water-vapour is a powerful equaliser of temperature, and a vapour-jacket of this kind is very efficient when it is required to maintain uniform temperature—not constant temperature. Mr. Watson described the method of Mr. E. H. Griffiths, who used tap-water as a negative source, and a gas-flame as a positive source, with extremely good results as a thermostat for constant and for uniform temperature.—The meeting then adjourned until March 24.

Entomological Society, March 1.—Mr. G. H. Verrall, President, in the chair. Mr. J. J. Walker exhibited a specimen of a rare British beetle, *Quedius longicornis*, Ktz., recently taken at Cobham Park, Kent. Mr. M. Jacoby exhibited a Halticid beetle from Sumatra, of the genus *Chalaenus*, Westw., and called attention to the remarkable position of its eyes, these organs being placed at the end of two very distinct lateral processes of the head, somewhat resembling the stalked eyes of crabs and other Crustacea. He said this character was peculiar to the male sex, and was very exceptional in Coleoptera, not being met with in any other genus of Phytophaga, and only occurring in a few Anthribidæ, and in isolated cases in one or two other families. He also showed a beetle from Peru, which was sent to him in a collection of Phytophaga, and, superficially, was very like certain members of that group; but from the structure of the antennæ and other characters, it appeared to be out of place in the Phytophaga, and probably belonged to some other family. Mr. Gahan remarked that this beetle, to whatever family it might prove to belong, was very interesting, not only from its structural peculiarities, but also from the fact that it had the colour and markings characteristic of certain species of Galerucidæ, a family to which it undoubtedly was not in any way closely related. This fact seemed to show that it was a mimetic form, and thus helped to explain the present obscurity surrounding its affinities.—Mr. G. J. Arrow contributed a paper "On Sexual Dimorphism in beetles of the family *Rutelidae*," and sent for exhibition a series, including both sexes, of six species of *Anomala*, selected to illustrate the subject of his paper.

Chemical Society, March 2.—Prof. Dewar, President, in the chair.—The following papers were read:—Bromomethylfurfuraldehyde, by H. J. H. Fenton and M. Gostling. The substance which gives rise to the purple coloration when ketohexoses are treated with hydrogen bromide in ethereal solution is a bromomethylfurfuraldehyde of the constitution

$$\begin{array}{l} CH : C-CHO \\ \;| \qquad\quad > O \\ CH : C-CH_2Br \end{array} ;$$

it has a golden yellow colour and seems only to be produced from ketohexoses or substances capable of yielding them by hydrolysis.—The reaction of alkyl iodides with hydroxylamine. Formation of alkylated hydroxylamines and oxamines, by W. R. Dunstan and E. Goulding. The hydriodide of trimethyloxamine $(CH_3)_3N : O$, is obtained by the action of methyl iodide on hydroxylamine; the base yields the iodide of trimethylmethoxyammonium by treatment with methyl iodide. The reactions of these substances are described, and also the products of the interaction of hydroxylamine with other alkyl iodides.—Derivatives of $\alpha\alpha'$-dibromocamphorsulphonic acid, by A. Lapworth. On heating ammonium α-bromocamphorsulphonate with bromine and water an $\alpha\alpha'$-dibromocamphorsulphonic acid, $C_{10}H_{13}Br_2O . SO_3H$, is formed; its acid bromide loses sulphur dioxide on heating, yielding $\alpha\alpha'\pi$-tribromocamphor, $C_{10}H_{13}Br_3O$.—Ethylic $\beta\beta$-dimethylpropanetetracarboxylate, by W. T. Lawrence. Ethylic $\beta\beta$-dimethylpropanetetracarboxylate, $CMe_2[CH(COOEt)_2]_2$, is obtained by the interaction of ethylic isopropylenemalonate with ethylic sodiomalonate; on hydrolysis with potash it yields $\beta\beta$-dimethylpropanetricarboxylic acid.—The action of metallic thiocyanates on certain substituted carbamic and oxamic chlorides; and a new method for the production of thiobiurets, by A. E. Dixon.—A reaction of some phenolic colouring matters, by A. G. Perkin. A number of metallic derivatives of colouring matters containing hydroxyl groups in relatively ortho-positions are described.—Note on the optical activity of gallotannic acid, by O. Rosenheim and P. Schidrowitz.

Royal Microscopical Society, February 15.—Mr. E. M. Nelson, President, in the chair.—The President called the attention of the Fellows to a beautifully made microscope by the late Andrew Ross, which had been presented to the Society by Messrs. Watson and Sons. It had a rotating foot, into which the standard was fixed eccentrically; this was not, however, an original idea, having been used by Cuff in 1760.—Mr. Beck exhibited a very ingenious and compact reversible compressorium designed by Mr. H. R. Davis. Dr. Tatham said that being made chiefly of ebonite, it was comparatively light, and in his opinion would be found a useful accessory by the naturalist.—Messrs. Watson and Sons exhibited a new model of their Van Heurck microscope, designed to give complete rotation to the stage, a feature which the President described as a step in the right direction, the great desirability of which he said had been insisted upon by Dr. Dallinger and Mr. Michael. Messrs. Watson also exhibited a new cover-glass clip devised by Mr. Pakes, of Guy's Hospital, for making blood films. Dr. Hebb thought it likely to be of use, especially as the technique of the blood was coming more and more into notice.—The President referred to the Martin microscope presented to the Society last year; he had come to the conclusion that it was not made by Benjamin Martin, but it was a very good imitation, probable date about 1850.—The President read a letter he had received from Mr. Keeley, of Philadelphia, with a slide of diatoms mounted on edge, and some photo-

graphs of the latter. The President said he had examined the slide, and could corroborate Mr. Keeley's description of the structure of the diatoms. With regard to the coscinodiscus and triceratium, he believed Mr. Morland was the first to work out and correctly describe these structures, and Mr. Keeley's observations confirmed those results; but he believed the account of the structures of heliopelta and auliscus now given was original. While he was on the subject of diatoms he wished to mention a very interesting discovery made by Mr. Morland, who found that the bracket which strengthened the "plate" in arachnoidiscus was neither more nor less than what an engineer would call a bead-headed girder, in the invention of which the engineer had only copied what nature had already accomplished in the strengthening girders of this diatom.—Dr. Hebb said the fourth part of Mr. Millett's paper on the Foraminifera of the Malay Archipelago had been received, but, owing to its technical character, he proposed that it should be taken as read.—The President read a paper descriptive of the Powell iron microscope, constructed by Hugh Powell in 1840; the instrument, which was exhibited in the room, was still in constant use by the President. Mr. Vezey suggested that an exhibition should be held of historic microscopes, showing the various stages of the development of the instrument; and the president said he hoped the Society would see its way to arrange for an exhibition of the character proposed by Mr. Vezey.—Mr. Rheinberg read a paper in explanation of the chief features of the exhibition of objects shown under multi-colour illumination, arranged under twenty-seven microscopes. The President said he believed one of the chief values of this method of illumination was that it might make it possible to use a larger axial cone than heretofore, and that if they could only combine the Gifford screen with this new method, he thought an advantage would be secured, but caution would be necessary in the selection of the colours. In photomicrography Mr. Rheinberg's method would prove useful.

CAMBRIDGE.

Philosophical Society, February 20.—Prof. H. Lamb, F.R.S. (Trin.), Victoria University, was elected a Fellow of the Society.—The following papers were communicated to the Society:—A semi-inverse method of solution of the equations of elasticity, by Dr. C. Chree. The usual procedure in attacking an elastic solid problem is first to determine expressions for the displacements involving arbitrary constants, thence to deduce expressions for the strains and stresses, and finally to determine the values of the arbitrary constants by the aid of the surface stress equations. In two papers published in 1895 the author obtained a complete solution for an isotropic elastic solid ellipsoid under certain important force systems, employing a semi-inverse method in which expressions for the stresses formed the basis of departure. Some little time ago the author noticed that not only was this method applicable to the corresponding problems in aeolotropy, but that the first stages of the work were absolutely the same for all kinds of homogeneous elastic material. The semi-inverse method thus leads at once to the solution of such a problem as that of an ellipsoid of any shape and any degree of aeolotropy rotating about a principal axis and self-gravitating. The procedure is perfectly straightforward, the only practical difficulty being the complication of the expressions for the three fundamental arbitrary constants which appear in the general formulæ for the stresses. In the present paper the aim has been to illustrate the method by applying it to a variety of the more interesting special cases, and not to chronicle general results of forbidding length and complication. For comparison with results found for rotating elongated or flat ellipsoids, the corresponding problems have been solved by a similar method for long cylinders and thin discs. Some of the results may interest those who are concerned with speculations about the structure of the earth, while others may prove of value to engineers.—On change of independent variables and the theory of cyclicants and reciprocants, by Mr. E. G. Gallop. The problem considered is the change of a system of n independent variables in a partial differential coefficient. The solution was given in a fully expanded form by Sylvester, and deduced by Cayley from a theorem due to Jacobi on the reversion of series. In this communication Jacobi's formula is developed in a manner somewhat different from Cayley's method, and a result obtained which leads on the one hand to Sylvester's expanded form, and on the other to a symbolical formula which is also applicable to any function of differential coefficients. This form involves n^2 quadro-linear partial differential operators analogous to the annihilator of ordinary pure reciprocants, and $n(n-1)$ lineo-linear operators of the type occurring in the theory of invariants. The formula can also be applied to the differentiation of implicit functions, and it is shown how a solution of the general equation of infinite degree, or of a set of such equations, can be exhibited in symbolical form. The method is then applied to the case of the general linear transformation and to the theory of cyclicants as developed by Prof. Elliott. Attention is also drawn to another class of reciprocants in n variables which, perhaps more naturally than cyclicants, may be regarded as generalisations of Sylvester's reciprocants in one variable. Conditions are obtained which ensure that a function of differential coefficients may be a reciprocant in this sense of the term.—On the combustion of carbon in electrolysis, by Mr. S. Skinner. A cell consisting of a carbon electrode in potassium permanganate and a lead peroxide electrode in dilute sulphuric acid produces a current flowing in the external circuit from the lead peroxide to the carbon. The permanganate ion is therefore brought against the carbon plate and becomes reduced, forming mainly carbon dioxide gas and permanganic acid. Such a cell has an electro-motive force of 0·33 volt. To find the relation between the carbon dioxide set free and the current, a voltameter containing potassium permanganate solution with a carbon anode and platinum kathode, was connected in series with a water voltameter and a current passed through them. With certain precautions it was found that one volume of carbon dioxide was set free for two volumes of hydrogen, and the author gives reasons for considering this result as determining the electro-chemical equivalent of carbon. The carbon dioxide produced in this way is not quite pure; it contains small percentages of oxygen and carbon monoxide.—On the ionisation of a gas by "Entladungsstrahlen," by Prof. J. J. Thomson. The paper contains an account of a series of experiments which show that the "Entladungsstrahlen" discovered by Prof. E. Wiedemann cause a gas through which they pass to become a conductor of electricity. The experiments show that with the discharge through a gas at a low pressure the region near the kathode produces more "Entladungsstrahlen" than the positive column, while none could be detected from the dark space between the positive column and the negative glow.

PARIS.

Academy of Sciences, March 6.—M. van Tieghem in the chair.—On some peculiarities of the theory of shooting-stars. Possibility of repetition of activity of certain radiant points. Existence of so-called stationary radiant points, by M. O. Callandreau. The observations of Mr. Denning on the existence of families of shooting-stars which diverge from the same point in the sky, with a maximum every three months, have been called in question by M. Tisserand, but in the author's opinion these observations cannot but be regarded as accurate, and their theory is discussed by the formulæ of Tisserand. The conditions necessary for the formation of the so-called stationary foci are also discussed mathematically, with application to the Orionids; shooting-stars from a fixed point near ν-Orionis having been observed by Denning over a period of twelve days.—M. Helmert was elected a Correspondant for the Section of Geography and Navigation in the place of the late Sir George Henry Richards.—Measurement of the diameters of the satellites of Jupiter and of Vesta by interference methods, carried out with the large equatorial of the Observatory of Paris, by M. Maurice Hamy. The numbers obtained were in general agreement with those of Michelson, the latter being slightly higher for satellites I., II., and III. The value for the minor planet Vesta (0″·54) agrees exactly with the micrometric observations of M. Barnard.—Absolute determination of directions making an angle of 45° with the horizon. Application to the measurement of latitudes, by MM. J. Perchot and W. Ebert. A mirror is floated upon an annular ring of mercury, and making an angle of $(45+x)°$ with the horizontal, x being the small error of setting. The method described allows of an exact determination of x. For most European observatories, not far removed from latitude 45°, the method has important advantages, the error due to flexure, in particular, being practically eliminated.—On the fundamental problems of mathematical physics, by M. W. Stekloff.—On analytical prolongation, by M. E. Goursat.—On an extension of the calculus of linear substitutions, by M. Cyparissos Stéphanos.—On the arithmetical nature of the number e, by M. Emile Borel.—On conjugate bundles, of which a system of curves are geodesics, by M. C. Guichard.—On certain systems of equations of

Laplace, by M. Tzitzeica.—On Green's and Cauchy's theorems, by M. Chessin. On a simple relation giving the molecular weight of liquids as a function of their densities and their critical constants, by M. Daniel Berthelot. By combining two laws found experimentally by S. Young and Mathias respectively, the author deduces the expression

$$M = 11 \cdot 4 d T_c p_c \left(2 - \frac{T}{T_c}\right),$$

where M is the molecular weight, d the density at any temperature T, T_c and p_c the critical temperature and pressure respectively. This formula is applied to a considerable number of substances, and a comparison of the molecular weights determined in this way with those obtained from the gaseous density shows that in general the molecular weights in liquids and gases are identical, water, acids, and alcohols being exceptions. The deviations found are probably due to the difficulties of ascertaining the correct critical pressures.—On tungsten bisulphide, by M. Ed. Defacqz. Two methods of preparation are described, the action of hydrogen sulphide upon the hexachloride, and that of sulphur upon tungsten trioxide at a high temperature. The physical and chemical properties are given.—Action of formaldehyde upon menthol and borneol, by M. André Brochet.—Estimation of copper and mercury in grapes, wines, lees, and grape skins, by MM. Léo Vignon and Barrillot. As a consequence of the application of salts of various metals for the destruction of parasitic diseases of the vine, it is necessary to examine the fruit products for traces of these metals. Suitable methods for estimating these minimal quantities are described, and satisfactory test analyses given.—Contribution to the study of the forms and conditions under which the chlorine of the soil usually enters into vegetables, by M. P. Pichard.—On the fermentation of galactose, by M. Dienert.—On some peculiar deformations of the blood corpuscles of fishes, by MM. J. Kunstler and A. Gruvel.—On the casting of the skin in insects, considered as a means of defence against animal and vegetable parasites. Special functions of the casting of the trachea and intestine, by M. Künckel d'Herculais.—Researches on the defensive glands of the Carabides, by M. Fr. Dierckx.—On some new Madagascan fossils, by M. Marcellin Boule.

DIARY OF SOCIETIES.

THURSDAY, MARCH 16.

ROYAL SOCIETY, at 4.30.—The Croonian Lecture: On the Relation of Motion in Animals and Plants to the Electrical Phenomena which are associated with it: Prof. J. Burdon Sanderson, F.R.S.—Experiments in Micro-metallurgy: Effects of Strain: Prof. Ewing, F.R.S., and W. Rosenhain.

LINNEAN SOCIETY, at 8.—A Further Contribution to the Freshwater Algæ of the West Indies: W. West and G. S. West.—On So-called "Quintocubitalism" in the Wing of Birds: P. Chalmers-Mitchell.—Some Facts concerning the so-called "Aquintocubitalism" in the Bird's Wing: W. P. Pycraft.

CHEMICAL SOCIETY, at 8.—Influence of Substitution on Specific Rotation in the Bornylamine Series: Dr. M. O. Forster.—Rotatory Power of Optically Active Methoxy- and Ethoxy propionic Acids prepared from Active Lactic Acid: Prof. Thomas Purdie, F.R.S., and James C. Irvine.

FRIDAY, MARCH 17.

ROYAL INSTITUTION, at 9.—The Electric Fish of the Nile: Prof. F. Gotch, F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Backwater or Hæmoglobinuric Fever: Dr. W. H. Crosse.

QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, MARCH 18.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S.

MONDAY, MARCH 20.

VICTORIA INSTITUTE, at 4.30.—Marks of Mind in Nature: Prof. Duns.

TUESDAY, MARCH 21.

ROYAL INSTITUTION, at 3.—The Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

SOCIETY OF ARTS, at 4.30.—The Commercial Development of Germany: C. Rozenraad.

ZOOLOGICAL SOCIETY, at 8.30.—Contributions to the Osteology of Birds. Part III. Tubinares: W. P. Pycraft—On the Marine Copepoda of New Zealand: G. Stewardson Brady.—On the Breeding of the Weka Rail and Snow-Goose in Captivity: F. E. Blaauw.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Papers to be further discussed: Water-Tube Boilers for Marine Engines: J. T. Milton.—Recent Trials of the Machinery of War-Ships: Sir John Durston, K.C.B., and H. J. Oram, R.N.——Paper to be read, time permitting: Alloys of Iron and Nickel: Robert Abbott Hadfield.

ROYAL STATISTICAL SOCIETY, at 5.—Causes of Changes in Pauperism in England, chiefly during the last Two Intercensal Decades: G. Udny Yule.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Automatic Adjustment of the Half-Tone Screen: W. Gamble.

WEDNESDAY, MARCH 22.

SOCIETY OF ARTS, at 8.—Electric Traction: Philip Dawson.

GEOLOGICAL SOCIETY, at 8.—Relations of the Chalk and Drift in Mœn and Rügen: Prof. T. G. Bonney, F.R.S., and Rev. Edwin Hill.—A Critical Junction in the County of Tyrone: Prof. Grenville A. J. Cole.

THURSDAY, MARCH 23.

SOCIETY OF ARTS, at 8.—London Water Supply: Walter Hunter.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Hissing of the Electric Arc: Mrs. Ayrton. (Illustrated by Experiments.)

FRIDAY, MARCH 24.

ROYAL INSTITUTION, at 9.—Transparency and Opacity: Lord Rayleigh, F.R.S.

PHYSICAL SOCIETY, at 5.—On the Criterion for the Oscillatory Discharge of a Condenser: Dr. Barton and Prof. Morton.—The Minor Variations of the Clark Cell: A. P. Trotter.

SATURDAY, MARCH 25.

ROYAL INSTITUTION, at 3.—The Mechanical Properties of Matter: Lord Rayleigh, F.R.S.

BOOKS, PAMPHLET, and SERIALS RECEIVED

BOOKS.—The Principles of Bacteriology: Dr. F. Hoeppe, translated by Dr. E. O. Jordan (Paul).—Electricity in Town and Country Houses: P. E. Scrutton (Constable).—Lectures on the Evolution of Plants: Dr. D. H. Campbell (Macmillan).—Measurement and Weighing: E. Edser (Chapman).—Les Plantes Utiles du Sénégal: R. P. A. Sebire (Paris, Baillière).—Naturalist's Directory, 1899 (U. Gill).—Iron-making in Alabama: Dr W. B. Phillips, 2nd edition (Montgomery, Ala.).—The Resources of the Sea: Prof. W. C. McIntosh (Clay).—Experimental Morphology: Dr. C. B. Davenport, Part 2 (Macmillan).—A History of Physics: Prof. F. Cajori (Macmillan).—Unités Electriques Absolues: G. Lippmann (Paris, Carré).—Théorie du Potentiel Newtonian: N. Poincaré (Paris, Carré).—Observations taken at Dumraon, Behar, India, during the Eclipse of January 22, 1898: Rev. V. de C. Campigneulles (Longmans).—Loup-Garou!: E. Phillpotts (Sands).—Bergens Museums Aarbog for 1898 (Bergen).—Universal Electrical Directory, 1899 (Alabaster).—Handbook of Physiology: Prof. W. D. Halliburton, 15th edition (Murray).—The Wild Fowl of the United States, &c.: D. G. Elliot (Suckling).—The Internal Wiring of Buildings: H. M. Leaf (Constable).—An Introduction to Stellar Astronomy: W. H. S. Monck (Hutchinson).—Twenty-four Test-Papers in Practical Plane and Solid Geometry (Science Subject 1), Elementary Stage: G. Grace (Macmillan).

PAMPHLET.—The Geology of the Borders of the Wash: W. Whitaker and J. Jukes-Browne (London).

SERIALS.—Observatory, March (Taylor).—Astrophysical Journal, February (Chicago).—Geographical Journal, March (Stanford).—Zeitschrift für Physikalische Chemie, xxviii. Band, 2 Heft (Leipzig).—Schriften der Naturforschenden Gesellschaft in Danzig, Neunter Band, Drittes und Viertes Heft (Danzig).—Mines and Quarries: General Report and Statistics for 1897, Part 4 (London).—Bulletin of the American Mathematical Society, February (New York).—National Geographic Magazine, February (Washington).—Quarterly Journal of Microscopical Science, February (Churchill).—Journal of the Institution of Electrical Engineers, February (Spon).—Middlesex Hospital Journal, February (London).—Engineering Magazine, March (222 Strand).——Atlantic Monthly, March (Gay).

CONTENTS.

THURSDAY, MARCH 23, 1899.

THE ART OF TOPOGRAPHY.

Recherches sur les Instruments, les Méthodes et le dessin Topographiques. Par le Colonel A. Laussedat. Vol. I. Pp. xi + 449. (Paris: Gauthier-Villars, 1898.)

IN his first volume on the art of topography Colonel A. Laussedat gives us an excellent sketch of the history and development of modern survey instruments, and an epitome of the opinions expressed by the best continental authorities on the subject of topography during the present century. The object of his comprehensive work is apparently to introduce to the scientific world the latest developments in the application of photography to the purposes of rapid delineation of topographical features, a comparatively new art which demands the attention of scientific surveyors in this country; but the present volume does not do more than touch this branch of his subject slightly.

The history of the evolution of the theodolite and other modern instruments is especially interesting, for it shows how very little the principles of construction have altered during the last three centuries. We have made enormous progress in the improvement of old instruments and in the application of old methods to surveying purposes, but the governing principles of triangulation, and of delineating country by means of the planchette, or plane-table, are so old as to be beyond even the historical evidence collected in Colonel Laussedat's book. Anything approaching to exact information only commences with the Arab geographers of the middle ages. They adopted the ancient instruments of the Alexandrian school, and improved on them. They even went to war with Greece in 829 A.D. because the Greek Emperor declined to lend them the services of a *savant* to extend their knowledge of mathematics. They borrowed their system of enumeration from India, and the magnetic compass from China; they observed their latitudes with the astrolabe (a very clear description of which instrument is given by Colonel Laussedat), and their longitudes by observations of the eclipse of the moon; and with these acquirements they made themselves masters of the Eastern seas. It is certain that Vaso de Gama made use of Arab pilots when he "discovered" the Cape route to India. Many authors attribute the invention of the plane-table to Pretorius, a Wittenburg professor, in 1537; but there is evidence of its existence in much earlier days to be found under classical authority. So obvious a method of map making, indeed, could hardly have escaped the Roman engineers, who were quite capable of turning out excellent plans of their cities in days anterior to our era.

The theodolite, which is only an adaptation of more ancient instruments, was reduced to something like its present form by Digges in 1571, and we find an alidade fitted with a vertical circle in use in 1590 in connection with the plane-table, so that, for three centuries, we have made no radical change in our principles of geographical surveying; although the introduction of the system of measurements by traverse and offset which are first recorded in the field book and then plotted in the office, has for many years superseded the more ancient use of the plane-table by the Ordnance Surveyors of England, for cadastral purposes. The history of the discussion on the relative value of these two methods of field work—"l'antique lutte entre la méthode du trace et du rapport immédiat des mesures sur le terrain, et cette des mesures inscrites sur un carnet et rapportées dans le cabinet"—is excellently well summed up by Colonel Laussedat. He is, however, mistaken in supposing that the discussion commenced in England with the lecture given by the American surveyor, Mr. Pierce, at the Civil Engineers Institute in 1888. Nearly ten years before that date, the advantages of the planchette, or plane-table, system of topography had been advocated at the R.U.S. Institute by Colonel Holdich, and instruction in this system had already been introduced into our military schools. England, in fact, has adopted this system for all countries and colonies with which she has surveying relations, outside England, but within her own borders the Ordnance Survey still maintains its position against all other civilised communities. But the use that is made of the plane-table (universal as it has once more become) is not quite the same all over the world; and in this branch of his researches Colonel Laussedat might, perhaps, have extended his review with advantage. The difference in its application to the various fields of continental or colonial survey lies chiefly in the amount of independence which is admitted of other and more exact methods of triangulation. Russians and Americans, for instance, by making use of a complicated plane-table, claim for it nearly all the potentialities of a small theodolite. English surveyors use it absolutely for topographical delineation, but subordinate it to primary triangulation with the theodolite. Its independence is not carried further than the limits imposed by triangulated and computed points or positions. What Colonel Laussedat fails to appreciate, is the advantage of mathematical proofs of the correctness of all that preliminary framework of fixed positions which is attained by the use of the theodolite. The correctness of such fixed positions is capable of mathematical demonstration quite apart from any survey process in the field. Within these limits no accumulation of error can occur, and it may be said that the demonstrable accuracy of the triangulated points is the gauge of the general accuracy of all details in the map. No position should be more inaccurate than the points from which it is interpolated. Where this proof supplied by computation is missing, there is no ready test of accuracy available. The surveyor who uses his plane-table only for graphic triangulation may accumulate error indefinitely, and no absolute check is applicable.

The net result of Colonel Laussedat's examination into topographical methods is that he gives his approval to the use of the plane-table in close alliance with the theodolite; and in this opinion he has the support of nearly all continental and most English surveyors.

When he comes to the consideration of the best method of representing the inequalities of ground, *i.e.* of giving proper value to the scales of shade indicating greater or less slope to be employed in cartography, there is very much in the book that is worth attentive study. Doubtless the system of continuous contours at equidistant vertical intervals is the most scientific and

the most practically useful. But it was long ago recognised in France that this system is only applicable to certain scales, and it was definitely laid down by the "Commission of 1826" that for scales smaller than 1/10,000 this system was insufficient. Then was introduced the expedient of "hachures" following the direction of greatest slope (*i.e.* what we call vertical hachures), and rules were laid down for the spacing of the strokes between the contours. As this is a subject which forms matter for constant discussion even now, it is interesting to note this first endeavour to deal with the problem systematically. No reference is made to horizontal hachuring, which we may presume has never been adopted by the French, although it is found of the greatest practical value in the geographical and military cartography of India.

The artistic effects gained by the assumed incidence of light is also dealt with; and here it is quite apparent that Colonel Laussedat's artistic perceptions have dominated his judgment. He is all in favour of adopting an affectation of oblique light to gain the effect of relief. And there is no doubt that the most perfectly artistic maps yet produced (the Swiss maps of the Alps) owe much of their effect to this expedient. But all theory of a true "diapason" (Colonel Laussedat's own expressive word) of shade to express slopes must disappear, if shadows are to be cast on the sides of mountains for the purpose of rendering them picturesque. Strong shade represents steep declivity or precipitousness, and if it is used for artistic effect only, it must lose its proper cartographic significance. It cannot be made to answer both purposes. With Colonel Laussedat's view of the utility of elevations and landscapes to illustrate a map we entirely agree, and it is here that the camera lucida and the photograph become effective. The former instrument is often used by geological surveyors in India with most admirable results, and it would be impossible to illustrate the accidents of rock formation in connection with geological maps by any more satisfactory method. The art of photography has not yet been applied to topographical purposes with similar success, but there may be a future awaiting it, with the development of which we trust that Colonel Laussedat will have something to say.

Incidentally the nature and use of barometric instruments are discussed in this book. Just at the present time, when the value of the aneroid barometer is under trial in connection with Colonel Watkins' new invention for throwing the instrument out of gear when not actually in use, this part of Colonel Laussedat's treatise is of special value. It indicates certain irregularities in the recording of instruments which he has personally tested, which do not appear to be in accordance with those of later observers (Whymper and others) in England. It may be *apropos* to this part of the subject to observe that the use of the aneroid for determining the orography of districts in India and Africa has been largely discontinued lately. With a certain number of fixed altitudes obtained trigonometrically, it has been found far more satisfactory to use a clinometer in connection with the plane-table. The alidade (or plane-table "ruler") has not been in any way modified for this purpose (although the introduction of a scale along the bevelled edge would be an obvious advantage), but a separate instrument carrying a level and a tangent scale is used for interpolating altitudes from fixed points by direct observation.

T. H. H.

GOLD MINING.

The Gold-fields of Australasia. By Karl Schmeisser, Obergrath, assisted by Bergassessor Dr. Karl Vogelsang; translated by Henry Louis, M.A., A.R.S.M., F.G.S., &c., Professor of Mining, Durham College of Science. Pp. 254 + xx. With 13 maps and plans in a separate volume. (London: Macmillan and Co., Ltd. New York: The Macmillan Company, 1898.)

The Witwatersrand Gold-fields Banket and Mining Practice. By S. J. Truscott. Pp. xxiii + 495. London: Macmillan and Co., Ltd. New York: The Macmillan Company, 1898.)

Transactions of the Institution of Mining and Metallurgy, London. Seventh Session, 1897–98. Vol. vi. Edited by Arthur C. Claudet, A.R.S.M. Pp. vi + 348. (London: Broad Street House, 1898.)

THE boom in the Witwatersrand gold mines in 1895 has been attributed, in part at least, to the famous Report made by Herr Schmeisser to the Prussian Government in 1893. Moreover, it is always refreshing to the investing public, weary of the perennial optimism of the ordinary mining expert, to come across an unprejudiced account of a gold-field written by a man whose reputation and experience give his statements the prestige of a Government Report. A peculiar interest therefore attaches to the appearance of this book, seeing that, with the recent enormous increase in the production of gold, it might have had a great effect on the fortunes of West Australia. It may, however, be said at once that Herr Schmeisser does not take any definite stand with regard to the land of "sand and sorrow." Certain districts, indeed, he condemns utterly as containing only lodes which pinch out and disappear completely at a very moderate depth, so that they may be expected to cease producing before long. As to other cases, he is still more pessimistic, believing that they depend entirely on pockets of rich ore, which are worked out almost immediately. Moreover, he fears that the generally patchy nature of the lodes will cause many disasters to companies now at work with available capital so small that development and prospecting are checked, and the miners will presently have barren reefs only in sight and no money to search for further rich deposits.

But, on the other hand, Herr Schmeisser waxes almost enthusiastic over the "composite" veins of Kalgoorlie, and over the possibility of new discoveries which the great unexplored tracts in the interior offer. The composite veins consist of a mixture of quartz veinlets and of clayey or talcose ferruginous rock, passing down at a depth of about 150 feet into undecomposed rock containing sulphides and tellurides of gold and of gold and silver. Very rich ore, containing from one to ten ounces of gold per ton, is found in many of the lodes in

a space about three-quarters of a mile wide and a mile and a quarter long, and seems likely to continue or increase in richness as depth is gained. Even from so small an area there is room for the production of millions of ounces, and if, as E. F. Pittman indicates, discoveries of similar deposits of tellurides are made along a line stretching for fifty miles from S.S.E. to N.N.W., the future of West Australia as a gold producer is guaranteed for many years to come.

One of the most interesting discoveries in this district was that of a lump of gold weighing 303 ounces in a quartz lode at Black Flag, six feet below the surface. Almost the only difficulty in accounting for the formation of placer gold, by supposing it to be derived from auriferous lodes by denudation, has been that large masses of gold occurred in gravels which had no counterpart in lodes. This difficulty has now been removed.

It might, perhaps, have been better if Herr Schmeisser had concentrated his attention on West Australia, and left the rest of Australasia alone. After quitting West Australia, his time was so limited that he could make only flying visits to a few localities, and has made scarcely a single original observation about one of them. Nevertheless the whole book is eminently readable, all the most interesting points in the subject being well brought out and dwelt upon. A striking picture of the contrast between the dry, hot, sandy plains of Australia and the deep ravines, splashing waterfalls and luxuriant vegetation of New Zealand is drawn in a few vigorous lines. The structure of the continent, too, is tersely indicated—a huge tableland, dipping from the sides towards the middle, and consisting of tertiary sands and Jurassic sandstones and limestones, flanked on the east and west by masses of granite and eruptive rocks. Finally, mention must be made of the admirable maps and plans, some of which are reproduced from the Government Reports issued by the various Colonies.

Another fine volume of a splendid mining series is Mr. Truscott's work on the Witwatersrand gold-fields. Some of the ground has been already covered in Messrs. Hatch and Chalmers' "Gold Mines of the Rand," but Mr. Truscott has done much more than bring that well-known book up to date. He has not confined himself to a popular account of his fascinating subject, but has treated it in a technical manner which makes his book of great value to mining engineers and students. There is little that is new in the account of the geology of the district, though it is perhaps surprising to find the view finally accepted that the gold in the banket was deposited there by infiltrating solutions, as in the genesis of auriferous quartz veins. Certainly no auriferous veins are so strikingly regular in value as the Witwatersrand conglomerates.

The greater part of the book, however, deals exhaustively with the mining practice as it existed in 1897, and this is almost entirely new ground. Not that the practice in the Transvaal differs greatly from the best work in other parts of the world, but there is here a picture of the latest and most approved methods of mining, modified as they have been by the local conditions of work. The chapters on sampling, on machine drills as compared with hand labour, and on sorting and ore dressing are particularly interesting, and much may be learnt in other countries from the results set forth; but, indeed, the whole book is well worth careful study.

The third volume of which the title is given at the head of this notice affords further evidence that, though the Institution of Mining and Metallurgy is one of the youngest of the technical societies, it publishes a capital journal, containing many interesting papers. There is a dearth of communications on the iron and steel industry, on coal-mining, and, indeed, on the industries of this country generally. These are all well looked after by other societies. The members of the Institution devote their attention mainly to gold and silver mining, and the extraction of these metals from their ores. Some of the papers have already been noticed from time to time in NATURE. The sixth volume, like its predecessors, is well printed, but would be perhaps improved if there were more diagrams to illustrate the papers.

OLD ENGLISH PLANT LORE AND MEDICINE.

Medical Works of the Fourteenth Century; together with a List of Plants recorded in Contemporary Writings, with their Identification. By the Rev. Prof. G. Henslow, M.A., F.L.S., &c. Pp. xv + 278. (London: Chapman and Hall, Ltd., 1899.)

SINCE the publication of Cockayne's "Leechdoms and Wortcunning," &c., and Prof. Earle's excellent little book on the "English Names of Plants," no work of the kind has been published until this volume of Prof. Henslow's; an important contribution which will be most welcome to philologists and botanists. The author is to be congratulated on the possession of so important a MS. as the one marked (A), which gave origin to his book.

Its philological value is well described in the preface by Prof. Skeat, who finds in it new and interesting features.

In the beginning of MS. (A) occur a number of recipes for the "steynyng of lynne cloþ," "to make red water" and "scarlet water," &c. One of the most striking of these recipes is that (p. 4) "to make soursikele water." This, says the note, is better spelt "saussicle, salsequium, or heliotrope, rendered in the list as ? *Cichorium Intybus*, ? *Tragopogon porrifolius*," both more than doubtful, "or *Calendula vulgaris*," a more likely plant to produce the required colour. The recipe says: "Take a tre that is like brasel, but it is more yellower in colour." . . . "Take it as thou dost brasel and lay that on thy cloth and do ye it in all manner as thou doust brasel." It is not clear in what this likeness consisted. It could not have been to the *plant Caesalpinia sappan*, which had been in use throughout Europe for centuries before King Emmanuel of Portugal gave the name of Brazil to the newly-discovered *Brazil* in the year 1500. It could therefore have been only in the colour of the dye that a resemblance was found.

Another recipe was "To make ȝelewe watere,—take goud englis woldes," which is not, what might be supposed, "woad," but "weldes," *Reseda luteola.*

Many other recipes for various shades of colour are given, and there must have been in early days a vast number of these plant-colours in use, if we may judge from the amount of delicate and lovely tints which are to be seen in the wonderful "Book of Kells," supposed to date from the eighth century, and now in the library of Trinity College, Dublin. A collection of recipes for these and other stains would be very interesting in explanation of the illumination-tints of the Anglo-Saxon period.

The remainder of MS. (A), as well as the whole of the three others—Harl. MS. (B), 2378; Sloane, 2584 (C); and Sloane, 521 (D), consist mainly of medical recipes similar in character to the "Leechdoms."

These have comparatively little interest in modern medicine except as literary curiosities, for it is remarkable how very few English plants remain as "survivals of the fittest" in the Pharmacopœia. Amongst this small number may be named *Hyoscyamus niger*, *Conium maculatum*, *Papaver somniferum*, *Spartium scoparium*, used *for staunching blood*, and not for the same purpose as in the present day; mugwort or wormwood, *Artemisia*, of which three species are given in the "Leechdoms," as well as in Prof. Earle's book. Besides these there are but few others in Mr. Henslow's list which have much value at the present time. It is not a little strange to find how almost completely English plants have been superseded in modern medicine by newly-invented compounds or by drugs imported from other countries, and it is to be regretted that more careful observation and trial of British plants are not made, as doubtless others might be discovered of marked value, as has been the case with *Convallaria* and *Taxus*.

Following the MSS. is a list of the medical and other plants of the fourteenth century, which is a model of its kind, containing all plant-names alphabetically arranged, the scientific names with which they have been identified, and the Old English sources from which they have been derived, reference being made to the page and line in each instance. If a book could be written on the same plan, including all the early English works, such as the "Leechdoms" and other similar writings, it would be of great value both to Anglo-Saxon scholars and to botanists, and would be an immense saving of trouble to the reading public, who would be under great obligations if so able an authority as Prof. Henslow would undertake the task.

There are singularly few exceptions which can be made to the present list; but it might be well under *Cyclamen*, which Earle gives as *Orbicularis* or "*Slite*," to note that the English word is omitted in it.

Gaytre, without much apparent reason (except the mention of *Cornel* in Chaucer, who, though he also speaks of "*Gaître-berries*," does not sufficiently identify them), referred to *Cornus sanguinea*. Might it not perhaps as fairly be assigned to the Gueldre rose, *Viburnum opulus*, a more harmless and edible fruit, of the *Sambucus* family?

It does not appear that *Cockel*, *Lolium temulentum*, is correctly referred to (A) 21^{18}.

One cannot part with this book without a word or two on the excellent style in which it is sent out. The binding and type, especially that of the specimen page of the MS., are attractive.

OUR BOOK SHELF.

The Chemistry of Coke. By O. Simmersbach; translated &c. by W. C. Anderson. Pp. viii + 159. (Glasgow and Edinburgh: William Hodge and Co., 1899.)

This excellent little work is a translation by Mr. W. Carrick Anderson of Simmersbach's "Grundlagen der Kokschemie," containing several important additions, notably a chapter on the methods employed for the examination and analysis of coal and coke. The work is rendered more valuable than most technical books of this character by the references, which make it a fairly complete bibliography of the subject. In a future edition it would be well to devote a special chapter to gas coke, which now only receives an occasional and inadequate mention, whilst a summary of the processes for the recovery of the bye-products of coke ovens would be a welcome addition to readers who do not possess Lunge's standard work on the subject.

The work is well and carefully done, whilst the statements made are mostly fully supported by the evidence adduced. On p. 76, however, the loss of carbon during quenching is represented by the equation

$$C_2 + 2H_2O = CH_4 + CO_2,$$

this statement being apparently made on the authority of an analysis by Frankland, who found in the gases evolved from Derbyshire coke and steam 56·9 per cent. of combustible gas, which he returns as a mixture of hydrogen and methane; but if Mr. Anderson analyses the gas produced under these conditions, he will find that the methane is a mere trace, and manifestly not produced in the way indicated by his equation.

The book can be heartily recommended to all interested in the manufacture and application of coke.

Class Book of Physical Geography. By Wm. Hughes, F.R.G.S. New edition, revised by R. A. Gregory, F.R.A.S. Pp. 328 + viii. (London: George Philip and Son, 1899.)

So much alteration in arrangement and text has been made in this new and enlarged edition of Prof. Hughes' well-known class book that it is practically a new work. In all directions we note additional matter which seems well adapted to meet modern requirements, and many new illustrations of exceptional merit have been introduced. A clear and comprehensive account is now given of the earth as a member of the solar system, and of the methods of ascertaining its form and size, as well as the positions of points upon its surface. The treatment of the various physical features of the earth is both clear and complete, and moreover is bright enough to make the subject attractive even to the general reader. Among the subjects which merit special mention are eclipses, winds, and climate, the first-named being illustrated by some excellent diagrams. The book has greatly gained in value in the hands of the present editor, and we confidently recommend it to the notice of pupil teachers and others interested in the subject.

English-French Dictionary of Medical Terms. By H. De Méric. Pp. vi + 394. (London: Baillière, Tindall, and Cox, 1899.)

This dictionary, in which the French equivalent is given for words and terms used in English medical science will be particularly valuable to French practitioners and students of medicine. The dictionary has been prepared upon a comprehensive plan, and includes, in addition to purely medical words, other words used in pathology, surgery, anatomy, and physiology, and also biological, botanical and zoological words met with in medical literature generally. The second part of the work (French-English), completing the dictionary, will appear shortly.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Radiation in a Magnetic Field.

THE application by Prof. Michelson of his interferometer to the study of the structure of the spectral lines has raised two important questions regarding the performance of this instrument; and it is to be hoped that perfectly satisfactory answers to both of them may be forthcoming in the near future. These questions are:

(1) Is the complex structure of the lines indicated by the interferometer a real structure existing in the light emitted by the source; or is it imposed, in part or altogether, by the apparatus employed?

(2) Supposing the structure referred to in (1) not to be spurious, but to be real, or partly real and partly spurious, can the interferometer be relied on as a measuring instrument for the purpose of determining the distribution of light in the complex line by estimation from the visibility curve?

With regard to (1), I may say that although it has been suggested that the structure indicated by the interferometer is entirely due to diffraction effects (or other unknown instrumental troubles), yet I personally am of opinion (from the study of Prof. Michelson's work) that the structure indicated is in the main real. It is possible, and indeed probable, that diffraction effects influence the final results in some small degree; but the main character of the indicated structure agrees, no doubt, with a real structure existing in the light emitted by the source.

The modifications introduced by diffraction (if any) ought to be detected from the fact that such effects are the same in character for light of all wave-lengths, and their magnitudes for different spectral lines depend on the wave-length only, and in no way on the nature of the radiating substance. For this reason I believe, with Prof. Michelson, that the structure indicated by the interferometer as existing in certain spectral lines, even when uninfluenced by the magnetic field, is a real structure; but as to whether it is all real, or to some small extent spurious, has not yet been placed beyond all doubt. The discovery of this structure adds one more to the already long list of achievements in the advance of science for which we are indebted to Prof. Michelson, and I trust he will place it beyond all doubt as to whether diffraction, or other causes, exert any appreciable influence in the instrument, or in any way mask the true structure. It is not sufficient to reply, as he does on p. 440 of this journal (March 9), that the explanation of this structure by diffraction effects "would be very difficult to accept, in view of the very great constancy of the results, with instruments of different construction and dimensions, with different observers, and with different forms of vacuum tubes employed"; for whether the effects are due to diffraction or not, they ought to remain the same under those circumstances here related, unless the "instruments of different construction" differ in principle and are not all interferometers. Diffraction cannot be the main cause if the character of the effect differs for different wave-lengths, and Prof. Michelson finds that it does differ for different spectral lines; and in the same way, I think, it might be determined if it intrudes itself as a modifying influence.

With regard to question (2) above, the charge against the interferometer remains most serious; nor is it diminished in any way by Prof. Michelson's further explanations given on p. 440. The case is this—the interferometer, when applied to the study of the splitting up of the spectral lines by the magnetic field, yields the law that the magnetic separation of the constituents "is *approximately* the same for all colours and for all substances." Now the facts of the case are that no such law holds, even as the roughest *approximation*. The magnetic separation is quite large for some lines, and very small, almost unobservable, in the case of others, and this even in the case of lines of nearly the same wave-length in the same substance. In fact the law yielded by the interferometer is nothing short of preposterous nonsense, and what remains to be done is to determine the causes of error in the instrument, or to standardise it, so that it may be employed as a measuring instrument. Of course, as I have already mentioned (NATURE, January 5, p. 228), the interferometer might have yielded this law without censure if by chance Prof. Michelson had happened to observe lines which suffer approximately the same amount of resolution in the magnetic field. But this is not the case, for in the case of cadmium the separation for the blue line is more than 30 per cent. greater than for the green line, yet the interferometer gives 0·41 for the green line and 0·40 for the blue. Similar remarks apply to the corresponding lines of zinc and magnesium; and what person, who has had even the slightest survey of these effects, can have any doubt as to the great difference in the magnitudes of the magnetic effects in the case of the green lines of magnesium and the green lines of copper?—and so on *ad infinitum*.

In conclusion, it may be well to mention that the relative intensities of the light in the components of the magnetically resolved lines, as observed by the eye in a good spectroscope (21·5-foot grating), are not by any means the same as those indicated by the interferometer. Thus in the figures reproduced on p. 440, the central components A (Fig. 1) are shown by the interferometer as possessing greater intensity than the lateral components B. But when the resolved line is observed by the eye (or photographed), it is at once seen that the illumination in the lateral components B (types II. and III.) is very much greater than that in the central components A. Type II. shows as a quartet (in which A is double) if the field is not very intense; but this quartet becomes resolved into a sextet, owing to the side lines B splitting up into doublets when the field becomes very intense. There is no trace of the further little "humps" pictured by Prof. Michelson, but the lines are clear and sharp—and it is possible that these little humps may be due to diffraction effects (?). Similar remarks apply to its relative illumination in type III.; and in this connection I may mention that although I did not give an illustration of the general type on p. 226, viz. that in which each constituent of the normal triplet is itself a triplet (figured by Prof. Michelson, p. 441, Fig. 3), yet I stated in the text of my article (p. 226) that "all the variations so far noted may be embraced in the general statement that each line of the normal triplet may itself become a doublet or a triplet." Indeed, these various types of effect were observed by me as early as November 1897, and have been communicated to the Royal Dublin Society from time to time.

THOMAS PRESTON.

Bardowie, Orwell Park, Dublin, March 16.

The Phenomena of Skating and Prof. J. Thomson's Thermodynamic Relation.

IN connection with Prof. Osborne Reynolds's "Notes on the Slipperiness of Ice," read before the Manchester Literary and Philosophical Society (NATURE, March 9, p. 455), the following extract from a brief paper, read by me before the Royal Dublin Society in 1886 (*Proc. R.D.S.*, vol. v. p. 453), may not be without interest.

"To the many phenomena which have found an explanation in Prof. J. Thomson's thermodynamic relation connecting melting-point with pressure, might be added those attending skating, *i.e.* the freedom of motion and, to a great extent, the 'biting' of the skate.

"The pressure under the edge of a skate is very great. The blade touches for a short length of the hog-back curve, and, in the case of smooth ice, along a line of indefinite thinness, so that until the skate has penetrated some distance into the ice the pressure obtaining is great; in the first instance, theoretically infinite. But this pressure involves the liquefaction, *to some extent*, of the ice beneath the skate, and penetration or 'bite' follows as a matter of course. As the blade sinks, an area is reached at which the pressure is inoperative, *i.e.* inadequate to reduce the melting-point below the temperature of the surroundings. Thus, estimating the pressure for that position of the edge when the bearing area has become 1/50 of a square inch, and assuming the weight of the skater as 140 lbs., and also that no other forces act to urge the blade, we find a pressure of 7000 lbs. to the square inch, sufficient to ensure the melting of the ice at $-3{\cdot}5^\circ$ C. With very cold ice, the pressure will rapidly attain the inoperative intensity, so that it will be found difficult to obtain 'bite'—a state of things skaters are familiar with. But it would appear that *some* penetration must ensue. On very cold ice, 'hollow-ground' skates will have the advantage.

"This explanation of the phenomena attending skating

assumes that the skater, in fact, glides about on a narrow film of water, the solid turning to water wherever the pressure is most intense, and this water, continually forming under the skate, resuming the solid form when relieved of pressure."

J. JOLY.

Geological Laboratory, Trinity College, Dublin.

Mammalian Longevity.

THE letter of Dr. Ainslie Hollis in NATURE of January 5, on "The Curve of Life," shows that the ratio existing between the periods of maturity and the periods of after-life in various mammals are capable of projection in a regular curve. This led me to inquire if the ratios might not be capable of reduction to a general formula. This seems to be the case, the statement being as follows :—

The full term of life in a mammalian species is equal to ten and a half times the period of maturity divided by the cube root of the period (of maturity), that is

$$\text{f. t. l.} = \frac{10\cdot5\,(\text{p. m.})}{\sqrt[3]{(\text{p. m.})}}, \text{ or } 10\cdot5 \times (\text{p. m.})^{\frac{2}{3}}$$

in which f. t. l. is the full term of life, and p. m. the period of maturity.

By the full term of life is meant the period that the animal would live, supposing that its existence were not shortened by enemies, accidents, disease, starvation, overwork or nervous strain ; and that it passed out of life by senile decay. This, of course, simply represents an average. It is generally accepted that the period of maturity is best measured by finding the age at which the epiphyses are united to the skeleton. It seems to be about from one and a half times to twice the period of puberty : one and two-thirds and twice seem common proportions. Man, for example, arrives at puberty at about fifteen, and is mature at twenty-five ; the lion and tiger arrive at puberty at three years, and are mature at six.

A table is given below, showing the periods of maturity and the full terms of life as obtained from the observations of breeders, scientific men, &c. ; and, for purposes of comparison, the full terms of life as calculated by the formula from the same periods of maturity. It will be seen that the two agree as closely as could be expected, especially when we bear in mind the difficulty of fixing with precision the normal life of a species, whose individual members will often die at widely differing ages, from different causes. Hence the different results obtained in many cases by different observers.

The approximation of the results of observation and the formula will be noticed. Blaine on the horse, is from the "Encyclopædia of Rural Sports." He seems to have studied the subject of the horse's age very closely. He says : ". . . a horse of five years may be *comparatively* considered as old as a man of twenty ; a horse of ten years, as a man of forty : . . and of thirty-five years, as a man of ninety." Up to ten years of age, then, the horse counts one year proportionately for every four of man, and as man's maturity takes place at twenty-five, this makes the horse's to occur at six and a quarter years. The full term of life given as equivalent to a man of ninety, thirty-five years is almost identical with the result of the formula. Darwin's observations on the elephant are from the "Origin of Species," where he discusses the increase of animals. The other references are from the works of various writers. It should be pointed out in connection with the dormouse, that Dr. Ainslie Hollis gave its full term of life as four years in NATURE and four and a half in the *Lancet* of January 21.

ERNEST D. BELL.

THE editor of NATURE has kindly forwarded me Mr. Ernest D. Bell's letter before publication. The formula therein stated is interesting, as it confirms the opinion, given in my previous letter on the subject, that a relationship exists between the duration of adolescence and thetlength of a mammal's life. Since the publication of the curve of life in NATURE, I find that the following domestic animals can be added to those already given. They conform to the requirements of the curve very closely, as may be seen :—

	Observed length of adolescence.	Length of Life. Observed	by curve	Computed by form.
Guinea-pig ...	7 months	6–7 years	7 years	7·33 years
English greyhound	1 year	12 ,,	12 ,,	10·5 ,,
Cat (Mivart) ...	1 ,,	12 ,,	12 ,,	10·5 ,,
Cat (Jennings) ...	2 years	15 ,,	18 ,,	16·67 ,,
Hog	5 ,,	30 ,,	31 ,,	30·7 ,,
English hunter ...	6¼ ,,	35 ,,	35 ,,	35·63 ,,

The age at which growth ceases in man differs considerably in different individuals of the same race. Otto observed all the epiphyses separate in the skeleton of a man, aged twenty-seven years (South's "Pathological Anatomy," p. 126). Such a skeleton could not have completed its growth for another ten or twelve years. The man, had he lived, might have truthfully posed as a youth when he was on the verge of forty. I have in skiagrams observed a difference of upwards of three years in the ages of different subjects, at which osseous union of the epiphyses to the finger-bones was effected. As the age of

Animal.	Observations. Authority.	p. m. Months.	p. m. Year.	f. t. l. Years.	f. t. l. by formula. Years.	Other observations. f. t. l.	Other observations. Authority.
Dormouse	Ainslie Hollis	3	·25	4 5	4·167	—	
Guinea-pig	Flourens	7	·583	6-7	7·33	—	
Lop rabbit—							
Buck	R. O. Edwards, p. m.	9	·75	8	8·67	8	Flourens
Doe	,, ,, p. m.	8	·667	8	8·013	8	,,
			Years.				
Cat	St. G. Mivart		1	12	10·5	—	
Cat	J. Jennings		2	15	16·67	—	
Goat	Pegler		1·25	12	12·18		
Fox	St. G. Mivart		1·5	13 14	13·76		
Cattle	Ainslie Hollis		2	18	16·67	15-20. 14	Flourens. Gresswell
Large dogs	Dalziel, p. m.		2	15-20	16·67		—
English thoroughbred horse	Ainslie Hollis		4·5	30	28·62	—	
Hog	James Long		5	30	30 7		
Hippopotamus.	"Chambers's Encyclopædia"..		5	30	30·7	—	
Lion	St. G. Mivart		6	30 40	34·67		
English horse—hunter	Blaine		6·25	35	35·63	—	
Arab horse .. .	Ainslie Hollis		8	40	42·00	—	
Camel	Flourens		8	40	42·00	40-50	Grindon
Man	Buffon, f. t. l.		25	90-100	89·77	90-100	Flourens
Elephant	Darwin		30	100	101·4	—	
Elephant	C. F. Holder and Indian hunters		35	120	112 35	120	De Blainville

twenty-five years for man's cessation of growth is therefore only an average one, in introducing that number as a factor of the curve, I thought that it would be manifestly an error to take examples of exceptionally long lives, when striking an average for length of life. In the curve as published in NATURE (which, although published somewhat before my communication to the *Lancet*, is really a revised curve), I reduced the age of man from eighty to seventy-five years from considerations such as I have just mentioned. Even seventy-five years is somewhat greater than the expectation of life given in Bourne's "Manual," for those who have completed the first half-century of their existence. The age given by Buffon, and quoted by Mr. Bell, is undoubtedly far too long. Similar considerations from some fresh data induced me to reduce the mean lifetime of the domestic mouse from four and a half years to four years, as noticed by Mr. Bell. W. AINSLIE HOLLIS.

Hove.

Barnes' "Plant Life."

In re centrosomes:

Poor misguided Prof. Zacharias! With absolutely no provocation, he now departs from "the almost universal consensus of opinion among good botanists" by saying of centrosomes (*Bot. Zeit.*, 572: 6, 1899):

"However, on an unprejudiced consideration of the literature involved, one may consider it not impossible that, on renewed search, the centrosomes will finally be again discovered where, for the present ('mark, Jew!'), they have been missed."

And Guignard! What a stupid he is to repeat in greater detail the blunder of figuring and describing those "discredited" centrosomes when all *good* botanists (who swear by Strasburger and his young American students) know that there are no such things! And to think of his calling them "Les centres cinétiques chez les végétaux" (see *Annales des Sci. Naturelles, Bot.*, viii. 5, 177–220, 1898), as though they were common! How "amazingly behind the times"!

But there must be more reason than assigned for designating "Plant Life" as "amazingly behind the times." Prof. Barnes would really be under obligations to the reviewer if he could find time to indicate by number of page or paragraph (doubtless marked as the book was yawned over) the statements to which he considers this phrase applicable. This request is made in all sincerity, and in the hope that the number of these passages will not be so great as to make it presumptuous in its demands upon the reviewer's time. C. R. BARNES.

THE reviewer cannot help regretting the evident pain which his remarks (vol. lviii. p. 519) have caused Prof. Barnes, though the latter can scarcely seriously believe that his arguments and assertions meet the original objections to which he has taken exception.

Prof. Barnes appears to be particularly aggrieved at the reference made to the figures and account of centrosomes, but his own explanations merely serve to give force to the reviewer's contention that they ought not to have found a place in an elementary book at all.

If the best final reply he can make is to quote the opinion of Zacharias to the effect that "it is not impossible that on renewed search the centrosomes will finally again be discovered," he should see that his case is parlous indeed. He has, in fact, cast a far greater slur on his own critical judgment than the reviewer would have ventured to do. His further quotation of Guignard's recent work might perhaps be regarded as somewhat *ex parte*, even had that investigator reiterated the old statements on which Prof. Barnes' account was based. As a matter of fact he does not do so, and his silence tells against our author.

The somewhat contemptuous reference to Strasburger (who is nevertheless *facile princeps* amongst botanical cytologists) and to those younger American botanists whose reputations, *pacè* Prof. Barnes, are largely founded on the splendid results achieved by them at Bonn, are scarcely calculated to increase one's regard for Prof. Barnes' power of discrimination.

Prof. Barnes appears to be quite unable to realise the degree of mental confusion which would be the inevitable lot of a student endeavouring to deal with the account given by him of the movement of water in plants. In one place (§ 204) root-pressure is spoken of as the force which causes the movement from the root to the evaporating surfaces of the leaves; but in § 207 the author rightly remarks that root-pressure is practically inoperative at the time when transpiration is most active. But he goes on to add that "recent experiments" indicate that the negative pressure of the gas-bubbles in the tracheids may be "a very important, or even the chief factor in lifting the water." After this one ceases to be surprised that no mention is made of the conclusions reached by Dixon and Joly, or by Askenasy!

But Prof. Barnes asks for further evidence for the reviewer's unfavourable opinion of the book. Only a few instances need be mentioned here, for if "this request is made in all sincerity," the author's own friends will easily supply more.

In a work of this kind, it is astonishing to find no mention of the occurrence of motile antherozoids amongst the lower phanerogams, which is perhaps the most important of all recent botanical discoveries—important for the student as clearly showing the connection between the higher and lower plants.

The account given in § 143 of annual rings is so preposterous as to call for no further comment.

The respiratory quotient of the ordinary plant is still given as unity, when, as a matter of fact, it is nearly always other than 1 in growing plants.

The statement that "true geotropic curvatures are brought about by the acceleration of the growth of the irritable cells" is, as it stands, absurd, for it involves no necessary *curvature* at all.

A student reading the account given in § 230 would naturally fall into the error of concluding that all the rays of light absorbed by chlorophyll are equally active in promoting assimilation.

In view of the evidence here adduced, at Prof. Barnes' own request, the reviewer considers that his judgment of the book was by no means unduly harsh or severe.

THE REVIEWER.

Optical Experiment.

BEING driven past a row of trees, I noticed that their intermittent shadow on the closed eye-lids gave rise to a vivid chessboard pattern of red and black squares arranged horizontally and vertically. These were perfectly regular, each being equal to about one-twelfth of an inch at ten inches distance. Waving the open fingers in front of the closed eye-lids exposed to the sun gave the pattern fairly well, but better by flashing the sun's rays across the lids by means of a vibrating hand-mirror. I see about seven or eight squares each way, the outer ones not well defined; but a younger man, who was not told what to expect, described them as more numerous.

What structure in the eye gives rise to the phenomenon? It is not caused by the eye-lids, because a piece of tissue-paper can be substituted, the eyes then being open. If the paper is white the squares are white and black. The pattern occupies the centre of the field of each eye. THOM. D. SMEATON.

Adelaide, South Australia, February 6.

A SEISMOLOGICAL OBSERVATORY AND ITS OBJECTS.

TEN years ago seismologists practically confined their attention to the movements of the ground which could be felt. In Italy and Japan, where these were frequent and sometimes violent, they attracted serious attention; whilst in Britain, where earth tremors were comparatively unknown, any suggestion that this country should establish a seismological observatory might only have cast doubts upon the mental balance of its author. At that time it was popularly supposed that in our islands earthquakes were of such rare occurrence that a special establishment for seismological investigations was unnecessary. Seismology, however, like several other sciences, has in a comparatively short period advanced with strides, and now stands as foster-mother not only to a Romulus and Remus, but also to a number of other children all filled with promise.

Now we know that in England, or in any other non-seismic region on the surface of the globe, at least seventy unfelt earthquakes, each of which have durations varying between twenty minutes and several hours, may be recorded yearly. The probability is that these movements are transmitted from their origins as compressional

and distortional vibrations through our globe, and the rate of transmission of the former is closely connected with the average depth of the path along which they have travelled. When our observations on these movements are more exact and numerous, we shall then know more than we do at present about certain physical characteristics of the planet on which we live.

At Utrecht, Potsdam and Wilhelmshaven, these unfelt movements frequently correspond in time with well-marked perturbations of magnetic needles, but inasmuch as similar needles are not disturbed at other stations, we are not quite certain that the observed irregularities in magnetograms are altogether the result of mechanical disturbance.

Then, again, we have the curious observation that at certain magnetic observatories prior to great earthquakes originating in their vicinity there have been uneasy movements in magnetic needles. When considering whether these observations are merely accidental coincidences, we must remember that the initial impulse or impulses of these disturbances have been sufficient to cause our world to palpitate from pole to pole, that they have sometimes been accompanied by bodily displacements of material sufficiently large to set the Pacific Ocean in a state of oscillation for many hours, and that the displaced material is in every probability highly charged with magnetite. We do not know the nature of the changes which were taking place in this material before its rupture, but we see in the final movement a possibility of sudden local magnetic disturbance.

Other possible connections between the movements of magnetic needles and those of horizontal pendulums lie in the facts that each have diurnal movements, and each may exhibit continuous or nearly continuous movement. The diurnal movements of horizontal pendulums are closely connected with effects accompanying solar radiation. The late Dr. Reinhold Ehlert, of Strassburg, saw in some of these a world distortion; whilst in others, my own observation leads to the supposition that their explanation is to be found in changes of surface-load brought about by evaporation, condensation, precipitation, and transpiration of moisture. To account for the almost unbroken continuity of earth tremors we are at a loss; but when we remember that in the world there is upon the average an earthquake occurring every half-hour which might be recorded, that probably there are many taking place beneath the sea and deep in our earth which are never felt, it does not seem unreasonable to look for their explanation in the vibrations accompanying these frequent adjustments in operation within the earth. If it is admitted that these continually moving materials are magnetic, not only do they suggest an explanation for the minute sinuosities on magnetograms, but they also indicate a possible relationship between hypogenic geological activity and secular magnetic changes.

In Japan, built up as it is round a core of rocks saturated with magnetite, which in their deeper portions are intensely hot, and therefore probably possess a reduced magnetic susceptibility, these earth tremors are apparently, and as we should expect them to be, more pronounced than they are in England or Europe. As to whether the *frétillements* on the magnetograms from that country are more frequent and distinct than those taken under similar conditions in non-volcanic countries, I leave to be answered by those who have the means of making the necessary comparisons.

That the records from a seismological observatory throw light upon sudden movements of magnetic needles at certain observatories is an established fact; but whether the bond connecting magnetic observations and those obtained by the seismologist is closer than is usually admitted, is apparently a matter worthy of consideration.

From a series of seismograms obtained from different stations we should be in a position to locate the site of sub-oceanic changes, and determine positions to be avoided by the cable engineer. A single seismogram may often set our minds at rest as to the cause leading to cable interruption, a matter of special importance to isolated Colonies, whilst it has repeatedly been the means of extending, confirming, or disproving ordinary telegraphic information. Another class of observations to which the seismologist devotes his attention are those indicating secular, seasonal and irregular changes in the vertical, which are of importance to the astronomer, earth pulsations and a variety of instrumental movements, the cause of which is not yet clear.

Although all the above-mentioned investigations can be carried out at a single observatory, the results to which they lead are by no means of equal value. For example, should we wish to know the velocities with which the vibrations of a given earthquake have been propagated along various paths through our earth, it is evidently necessary to have the means of making comparisons between seismograms obtained from similar instruments at widely separated stations. It is a pleasure to state that the necessary co-operation here indicated has been obtained, and in response to an invitation issued by a Committee of the British Association, the directors of observatories at the following places have kindly undertaken to make the necessary observations: Kew, Paisley, San Fernando (Cadiz), Cairo, Beirut, Cape of Good Hope, Mauritius, Madras, Calcutta, Bombay, Batavia, Tokio, two in New Zealand, Cordova (Argentina), Honolulu, Victoria (B.C.), Toronto, Philadelphia, Arequipa, Mexico, Trinidad. Certain of these are already sending in records.

What is now required in Great Britain is not simply a central office where these records can be examined, but also a station at which a variety of seismological observations can be made which will be comparable with the records from corresponding instruments similarly installed in other localities. As illustrative of this, although it would be extremely interesting to note the varying effects of barometrical pressure upon the plains of Lincolnshire, and to compare the magnitude and period of earthquake waves as recorded there with those recorded on a rocky surface, it is extremely probable that the records of diurnal waves from such surfaces, or in fact from any two, but different alluvial or soft foundations, would only yield results of local value. Any haphazard selection of a site for a laboratory might take us to a place where we might find an apparent diurnal or other variation in gravity, and where the same gold bead upon an assayer's balance rapidly changing its zero, might appear to have a different weight at different times. Then, again, if we wish to study the continuous trembling of our earth, we require to be on solid materials at least half a mile from a railway, and some distance from any source of artificially produced vibration. If in addition to this it should ever be found desirable to obtain a highly magnified record of the movements of a magnetic needle, it is obvious that we must be far removed from the possibility of electrical disturbance.

What is required, and especially for earthquake recording, is a platform or foundation which continues downwards as a uniform mass into the interior of the earth. Such conditions may probably be met with upon certain granite bosses, but it is likely that the greatest continuity would be found upon an old volcanic neck, of which we have very many illustrations in these islands. Although these are mere *coup d'épingles* in the crust of our earth, it is not unlikely, especially when their lateral dimensions increase with depth, that they convey more vibrational energy to the surface than is conveyed through discontinuous sedimentary strata.

If in connection with diurnal waves we wish to record sunshine, or to note the rise and fall of stars or distant objects as seen through a telescope at the time of large earth waves, the station should command, especially in an east and west direction, a fairly extensive horizon.

Inasmuch as an observer may, as a means by which "air tremors" can be destroyed, require in one of his rooms a copious ventilation with a minimum of dampness, a precaution of some importance is not to ignore the hygrometric conditions of a locality.

A good site having been found, the remaining requirements for a seismological observatory are small. All that is necessary is a small one-storied structure. It should contain one or two large rooms in which to place some half-dozen instruments, and three small rooms to be used respectively as an office, a workshop and a dark room.

In Italy there are fifteen observatories of this order, and a very large portion of the work is to record movements of the earth's crust, which can be equally well recorded in England. At Strassburg, which is as free from earthquakes as any town in England, a seismological observatory, costing 3500*l*., with an annual grant for maintenance of 275*l*., is being erected. Austria and Germany are establishing stations, whilst the great work which for years past has been carried out in Japan is too well known to require restating.

In conclusion, when we consider that the observations made at a seismological laboratory are connected with those made by the meteorologist, the geologist and the astronomer, that they suggest problems to the elastician, shed light upon perturbations of magnetic needles, are of direct importance to the cable engineer, and in the interpretation of certain telegrams, and that in many other directions they are of value both scientifically and practically, it seems strange, especially in the face of the hearty co-operation we have received from abroad, that this country is yet without a definite centre at which these observations can be carried on.

JOHN MILNE.

SATURN'S NINTH SATELLITE.

ON Saturday last, March 18, the astronomical world, somewhat recovering from the excitement incident to the discovery of the remarkable asteroid now named Eros, was again pleasantly surprised by the news of another "find," distributed by telegram from the Central Astronomical Bureau at Kiel. This time it is the planet Saturn which supplies the feature of interest, in that an addition to its already numerous family of attendant satellites has been discovered by Prof. William H. Pickering, assistant astronomer at Lowell Observatory, Flagstaff, Arizona. The name of this station will be familiar to all in connection with the many notable observations of the planet Mars which have been made there by Mr. Lowell, its director, with the 24-inch refractor. Most of this work is so delicate as to need the best conditions for seeing, and it is only the extremely favourable situation of this observatory which has rendered them possible. This is probably to be attributed to the extreme transparency of the air consequent on the high altitude above the sea-level.

The new satellite has been run to earth, as it were, by photography. On examination of four photographs of Saturn, Prof. Pickering found traces on each of a very faint object, the behaviour of which led him to consider it to be a satellite of the planet. The little stranger is estimated to be of the 15th magnitude, so that it is unlikely that it would ever have been discovered by visual observation, even in the huge instruments now at the disposal of our leading astronomers. Measurements of the coordinates of its position from the four plates have furnished the data for computing its period or time of revolution round the parent planet, and this is found to be about *seventeen* months. This indicates that it will take its place as the outermost of the nine satellites, the period of Japetus, the furthest from Saturn of the known ones, being only about 79⅓ days. While the distance of Japetus is 2,225,000 miles, that of the new moon will therefore be about 7,500,000 miles, and this, combined with its extremely slow motion, all tended to diminish the chances of its detection by the usual method of tracking non-stellar objects by the elongated trails they leave on the photographic plate, the stars being shown as symmetrical round dots.

It is interesting to note how the gradual discovery of the attendants of the various planets has influenced the compounding of the "laws" which from time to time have been found to approximately represent the positions of these bodies in the solar system. From the first discovery of Jupiter's four satellites by Galileo in 1610 to the recognition of the already known eight of Saturn by Huyghens, Cassini, and Sir W. Herschel, no regular relationship was perceived. When, however, in August 1877, Prof. Asaph Hall discovered the two moons of Mars, Deimos and Phobos, with the newly-erected 26-inch refractor of the United States Naval Observatory at Washington, it was seen that all the then known satellites were grouped in a geometrical progression, reckoning outwards from the Earth. Thus the Earth had one, Mars two, Jupiter four, and Saturn eight. This seeming regularity was broken by the discovery on September 9, 1892, of a fifth satellite to Jupiter by Prof. E. E. Barnard at the Lick Observatory. This last discovery of a ninth satellite for Saturn will furnish a reason for a new series being formed, as counting from the Earth outward from the Sun, the numbers of satellites to the planets Earth, Mars, Jupiter, and Saturn are now 1, 2, 5 and 9 respectively, and these numbers are very nearly proportional to the distances of those planets from the Sun.

No information is yet to hand as to the diameter of this newly-found member of the solar system. From its brightness it may be from 100–200 miles, but its measurement will be extremely difficult.

The importance of photography in astronomical research is very well illustrated in the case of this event. Although it might be possible to see the satellite under good conditions, it is easy to understand how many times such an insignificant object might be passed over among so many more prominent ones. Once it has impressed its image on a photographic plate, however, it is caught, and its detection is sure, sooner or later, on complete examination of the negative. Then the possibility of duplication removes all doubt of personal error of any kind. Another advantage of the photographic plate over the eye is that the longer it is exposed, so much fainter objects will it record; while, on the other hand the eye only becomes more fatigued the longer it is used in the search.

It should be instructive to notice how most of the astronomical discoveries of late years hail from across the Atlantic. Whether it is that the love of science is more generally developed there, or that the liberal endowment of a scientific institution is considered the most serviceable way of handing one's name down to posterity, it is certain that in the establishment of the Harvard College, Lick and Yerkes Observatories the American people have placed themselves ahead in astronomical matters; and there is little doubt that they are well satisfied with the results obtained by means of their liberality.

A later telegram to the *Standard* states that the discovery was made with the Catherine-Bruce telescope, an instrument of large aperture and short focal length.

C. P. BUTLER.

NOTES.

We regret to see the announcement of the death of Prof. O. C. Marsh, the distinguished palæontologist of Yale University.

The French Minister of Public Instruction has nominated Prof. Poincaré president of the Bureau des Longitudes; M. Faye, vice-president; and Prof. Lippmann, secretary.

The annual meeting of the Iron and Steel Institute will be held on Thursday and Friday, May 4 and 5, commencing each day at 10.30 o'clock a.m. The President-elect (Sir William Roberts-Austen, K.C.B.) will deliver his inaugural address; and papers promised by Prof. J. O. Arnold, Mr. H. Bauerman, Mr. E. Disdier, Messrs. Jeremiah and A. P. Head, Baron H. von Jüptner, Prof. H. Louis, Mr. Bertrand S. Summers, and Prof. Wiborgh are expected to be read and discussed. The annual dinner of the Institute will be held in the Grand Hall of the Hôtel Cecil on May 4. The autumn meeting of the Institute will be held in Manchester on August 15–18.

A dinner which took place at the Fishmongers' Hall on March 14, possesses especial interest to us, on account of the fact that it was given in honour of science, and that the guests included a great number of scientific men, among them being the Presidents of the following Societies and scientific bodies: Royal, Royal Horticultural, Royal College of Physicians, Royal Geographical, Dermatological, Royal Microscopical, Victoria Institute, Royal Statistical, Royal College of Surgeons, Royal Astronomical, Zoological, Linnean, Chemical, Entomological, Philological, and Clinical. The toast of the evening was "Science," and was proposed in an eloquent speech by the Prime Warden, Mr. J. A. Travers, who pointed out the great advance science had made in the last twelve years; he recommended, further, the special study of preventive medicine, to ensure for Great Britain a safer footing in foreign climates. Lord Lister responded to the toast, and urged City Companies to support pure science; he referred also to the help they had rendered the Jenner Institute. Sir William MacCormac then proposed the health of the Prime Warden. The occasion is noteworthy in that it indicates the growing recognition of the value of scientific work.

On March 18 the Austrian Society of Engineers celebrated its jubilee in the Municipal Council Chamber, Vienna, under the presidency of Mr. F. Berger. There was a large attendance of members; and representatives of sixty-six kindred societies presented addresses. Congratulatory speeches were delivered by the Austrian Minister of Railways, the Minister of Commerce, the Governor of Lower Austria, the Secretary of the Iron and Steel Institute, London, the Secretary of the French Society of Civil Engineers, Paris, and the Secretary of the Society of German Engineers, Berlin. A paper was then read by Mr. A. Rücker on the part taken by the Austrian Society of Engineers in the technical progress of the past fifty years. The Austrian Society is a very influential one. At its foundation in 1848 it numbered seventy-nine members; at the present time there are 2388.

Dr. J. N. Langley, F.R.S., University Lecturer on Histology, Cambridge, has been elected a member of the Athenæum Club under the provisions of the rule which empowers the annual election by the Committee of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

The anniversary meeting of the Chemical Society will be held on Wednesday, March 29, at 3 p.m. Prof. Dewar has presented to the Society a daguerreotype of Dalton, the portrait being one of two taken in 1842. In expressing thanks for the gift on behalf of the meeting at which Prof. Dewar announced his intention of presenting the daguerreotype to the Society, Prof. Tilden remarked that he believed that the well-known portrait of Dalton engraved by Jeans, and appearing as the frontispiece in Roscoe and Schorlemmer's "Treatise on Chemistry," was prepared from a drawing made from this daguerreotype.

Father R. P. Colin, known for his cartographical works on Madagascar, has been elected a correspondant of the Paris Academy of Sciences, in the section of geography and navigation.

The Paris correspondent of the *Times* states that the French Minister of Agriculture has created at the Agronomic Institute a chair of biology of plants cultivated in France and her Colonies.

The steamer *Southern Cross* has arrived at Port Chalmers, New Zealand, from Victoria Land, with Mr. Borchgrevink and the other members of the Antarctic expedition under his charge.

Prof. Duclaux, director of the Pasteur Institute at Paris, has had the honour of the second class of the Osman Order conferred upon him by the Sultan.

The New York Academy of Sciences will hold its sixth annual exhibition in the American Museum of Natural History on April 11 and 12. The exhibition will illustrate the advances in various departments of science during last year.

A deputation of the Decimal Association to the President of the Board of Trade, in favour of the compulsory adoption of the metric weights and measures in this country, was arranged for yesterday as we went to press.

The Associated Chambers of Commerce passed the following resolution at one of their meetings last week:—"That, in view of the time wasted in teaching a system of weights and measures which, according to the First Lord of the Treasury, is 'arbitrary, perverse, and utterly irrational,' and in the opinion of Her Majesty's Consuls is responsible for great injury to British trade, this association urges Her Majesty's Government to introduce into and endeavour to carry through Parliament as speedily as possible a Bill providing that the use of the metric system of weights and measures shall be compulsory in this country within two years from the passing of the Bill, and suggests that meanwhile the system should be adopted in all specifications for Government contracts."

The proposal to place in Corsock Parish Church, by half-guinea subscriptions, a memorial window in memory of Prof. James Clerk Maxwell has already been referred to in these columns. A correspondent informs us that, to complete the window, about 40*l.* more is required. There should be no difficulty in obtaining this amount from admirers of Clerk Maxwell who have not yet subscribed. Subscriptions may be sent to Rev. George Sturrock, The Manse, Corsock, by Dalbeattie, N.B.

A question was asked in the House of Commons on Thursday as to when the North Sea Fisheries Conference would get to work, how the conference would be constituted, and what instructions would be given to it. In reply Mr. Brodrick said: "The Foreign Office are quite aware of the urgency of this question, and have urged the Swedish Government to hurry on the assembly of the conference. The conference will meet in the month of May, and delegates will be sent by the various Powers concerned. This question will be considered by experts and by practical men sitting together. The programme of the conference is now before Her Majesty's Government."

THE report of the Council of the Scottish Meteorological Society, presented at the general meeting of the Society yesterday, mentions, among other matters, that the observations at the two observatories on Ben Nevis are now ready to go to press, down to December 1896, together with a general discussion of the results, and several other discussions of separate important inquiries raised by the observations. A paper on the meteorology of Ben Nevis, accompanying the hourly observations, was read by Dr. Buchan at the meeting of the Royal Society of Edinburgh on March 6. Among the papers in the number of the Society's *Journal* to be published during the coming summer will be a discussion of the annual rainfall of Scotland from the beginning of the century to 1898, with tables giving the annual amounts at many stations from which long-continued observations are available. Another paper will be a discussion of the observations on fog, made at the Scottish lighthouses for the ten years from 1889 to 1898. The heavy and tedious work of charting on daily maps of Scotland the rainfall at 120 stations, the fog at the lighthouses, the storms of wind reported at the lighthouses as having actually occurred, along with the phenomena of weather noted at the Society's stations, proceeds apace, and already about a year and a half of this work may be regarded as completed. This means the construction of 487 maps, specimens of which were shown to the meeting. Grateful reference is made to the gift of 500*l*. by Mr. J. Mackay Bernard, of Kippenross, for the high- and low-level observatories at Ben Nevis. As the result of this patriotic beneficence, the work of the two observatories is still being carried on by the directors.

THE death of Mr. Jeremiah Head, on March 10, deprives the engineering profession of one who has played an important part in mechanical science during the middle and latter part of this century. From an obituary notice in the *Times*, we learn that Mr. Head was born at Ipswich in 1835, being a descendant of an old Quaker family, and was apprenticed in 1854 to Robert Stephenson at Newcastle-on-Tyne. During the term of his indentures he so distinguished himself that when out of his time he was taken on the designing staff of the great civil engineer. In the year 1864 Mr. Head became a partner in a business for the manufacture of iron plates, and after spending twenty years in it, the works were sold to another firm, and Mr. Head became a consulting engineer. With his son he did some notable work during the last few years in bringing before the notice of British steelmakers some of the more important advances that have been made in America in the manufacture of iron and steel. In 1896 he read a paper before the Institution of Civil Engineers on the American and English methods of making steel plates; and so lately as last month he and Mr. A. Head contributed a joint paper to the same institution on the "Lake Superior Iron Ores." These two papers were a revelation to a large number of people in this country, who had not realised how rapidly the Americans were forging ahead in the production of iron and steel, and the many improvements that had been introduced into Transatlantic practice. Mr. Head was president of the Institution of Mechanical Engineers during the years 1885–86, when the institution was passing through a very critical period of its existence. In 1893 he was president of the Mechanical Science Section of the British Association. He was a member of numerous technical and scientific societies, including the Institution of Civil Engineers. He founded the Cleveland Institution of Mining Engineers in the early sixties. Although this is but a local society, it has had great influence on the iron and steel industry of the kingdom, and has been instrumental in causing the Cleveland district to be considered the centre of the British iron industry.

AGAIN the world's record for kite-flying for scientific purposes has been broken at the Blue Hill Observatory, Massachusetts. On February 21 an altitude of 12,440 feet was reached by a recording instrument attached to a string of tandem kites. This is 366 feet higher than the preceding best record. The flight was begun at 3.40 p.m., the temperature at the surface being 40° and the wind seventeen miles an hour. At the highest point the temperature was 12° and the wind velocity fifty miles an hour. Steel wire was used as a flying line, and the kites, four in number, were of an improved Hargreave pattern, with curved surfaces, made after the pattern of soaring birds' wings. The upper kite carried an aluminum instrument weighing four pounds, which recorded graphically temperature, wind velocity, humidity, and atmospheric pressure. The combined kites had an area of 205 square feet and weighed twenty-six pounds, while the weight of the wire was seventy-six pounds. The upper kite remained above two miles for about three hours.

CHARCOAL has been used for many years in Australia to precipitate gold on a large scale from its solution as chloride, and it is doubtless this circumstance which has led to its employment in Victoria to precipitate gold from cyanide solutions. In a paper by Mr. J. I. Lowles, read at the meeting of the Institution of Mining and Metallurgy on March 15, the details and results of the process are given, from which it appears that the expense and inconvenience are far greater than in zinc or electrolytic precipitation. At a typical cyanide mill in Victoria, 10,000 lbs. of charcoal contained in 198 tubs are in constant use to precipitate 700 ozs. of gold per month. To recover the gold the charcoal is burnt, and the ash melted with borax in crucibles. In the course of the month about 8 cwt. of ash is melted with 16 cwt. of borax, the total cost being over 1*s*. 6*d*. per oz. of bullion 900 fine, exclusive of the waste of cyanide which occurs as the solution passes through the charcoal. The chemical interaction involved in the precipitation is not understood.

DR. ALEXANDER AGASSIZ'S munificent gifts of natural history collections to the Museum of Comparative Zoology of Harvard University have already been mentioned in these columns. In the annual report of President Eliot an extract is given from the records of the Corporation of the University, in which the Corporation specify the gifts and express gratitude for them. It appears from this that Dr. Agassiz has never received any salary for his services to the museum in various capacities since 1860. Between September 1, 1871, and September 1, 1897, he expended for the benefit of the museum from his private means, without making any communication on the subject to the President and Fellows, over seven hundred and fifty thousand dollars, including his expenditures on objects now formally transferred to the Corporation, beside contributing about fifty thousand dollars to other university objects in gifts known at the time to the President and Fellows. Dr. Agassiz has thus shown, by devoted service and generous benefactions, his deep concern for the welfare of the museum in which his distinguished father took so great an interest.

THE last *Bollettino* (vol. iv. No. 7) of the Italian Seismological Society contains a valuable study, by Dr. A. Cancani, of the Adriatic earthquake of September 21, 1897. This was by far the strongest earthquake felt in Italy during that year, its disturbed area containing about 235,500 sq. km. The origin, as shown by the isoseismal lines and the observed directions of the shock, lay beneath the Adriatic, about 20 km. from the coast between Pesaro and Ancona. At least two distinct kinds of undulations were perceptible, even without the aid of instruments—namely, rapid vibrations with a period of from $\frac{1}{6}$ to $\frac{1}{2}$ a

second, and slow oscillations with a period about ten times as long. Within the disturbed area, the earthquake-wave travelled with a velocity of 1·6 km. per second, and, beyond its boundary, as far as Utrecht (1050 km.), with a mean velocity of 3·6 km. per second. Dr. Cancani regards the earthquake as one of a series, probably connected with the bradyseisms of the Adriatic coast of Italy, the existence of which has been proved by Issel; and he points out that the stronger earthquakes of the series appear to recur at intervals of about a century, and others at an average interval of about twenty-three years.

The Meteorological Council have just issued their report for the year ending March 31, 1898; the considerable delay in the date of publication is due to the form of first submitting it to the Council of the Royal Society and its subsequent presentation to Parliament. The Council continue as in past years to collect data relating to the meteorology of the ocean, and to supply instruments to the Royal Navy and to observers in the Mercantile Marine. The investigations in progress in this branch during the year in question were (1) the meteorology of the Southern Ocean, between the Cape of Good Hope and New Zealand, and (2) the meteorology of the South Atlantic and the west coast of South America. Statistics as to the climates of foreign ports are from time to time supplied to the Admiralty for use in various publications. The results of the forecasts which appear in the morning newspapers show a complete or partial success of 81 per cent., the average for the last ten years being 81·3 per cent., while the results of the special forecasts issued during haymaking season show that 90 per cent. were useful. The success obtained for the storm warnings issued to seaports reached the high figure of 91·8 per cent. In the branch relating to climatology, hourly means of observations made at the principal observatories, and results of the observations at stations of the second order, have been published in the same form as in previous years. Among the miscellaneous investigations, the important subject of anemometry has occupied a prominent place, and the subject of atmospheric electricity has been brought under consideration with a view to utilise the records that have been made at Kew Observatory for many years past.

The Council of the Essex Field Club appeal to those taking an interest in the spread of information on natural science, and in popular education, for donations towards the capital sum of 1000*l.* required for the equipment of the Essex Museum of Natural History at Stratford. It will be remembered that the first stone of this museum was laid in October last. The cost of the building and ground will be about 6000*l.*, towards which Mr. Passmore Edwards contributes 2500*l.*, on condition that the museum shall contain the Essex Field Club's county collections of natural history. The balance of the cost, and the upkeep of the building, will be defrayed by the Corporation of West Ham, acting through their Technical Instruction Committee. The fitting-up of the museum with cabinets, cases, jars, boxes, &c., to contain the various collections, and the numerous and expensive appliances of an educational collection, has to be undertaken by the Essex Field Club, and it is to provide this equipment that the Club makes an appeal to its members and others interested in the extension of scientific knowledge.

At the meeting of the Anthropological Institute, on February 14, Mr. H. P. Fitz-Gerald Marriott read portions of a lengthy and very complete paper on the secret tribal societies of West Africa. He said that they were merely tribal developments, and not bands of conspirators. He described some of them, such as the Purroh and Kofong, referring to their ritual and dress; but he made known for the first time the few harmless religious societies of the Gold Coast which are unknown to local white residents, not being so highly developed as those in the Sierra Leone or the Niger districts. The societies appear to present a good example of what is generally the case throughout the world, in that the highest grades as a rule are the simplest in externals. Mr. Marriott finished his paper by mentioning a widespread Egyptian or Arabian society called Siri, which existed for the study of magic and occult matters; it had ramified itself all over the western portion of Africa; it is a key to the study of the tribal societies, and it has probably much influenced them. There were also reasons stated to show that monotheism existed in certain portions of Central Africa. The tribal societies must not be confused with murderous leopard societies, which natives themselves regard as we do anarchists; but beyond the civilised boundaries, in many parts where the tribal society was strong, it could be employed for such objects as obtaining labourers, carrying out British laws and other laudable objects by a channel to which the natives were accustomed.

The Geological Survey of England and Wales has just issued an important practical Memoir on "The Water Supply of Sussex," by Mr. William Whitaker, F.R.S., and Mr. Clement Reid (price 3*s.*). The work deals with the supply of water from underground sources, and is mainly made up of the records of wells and borings. The details of the strata passed through, the grouping of them under the various geological formations, and other particulars are carefully stated; and these records are supplemented by a number of analyses of waters. In the Introduction there is a brief outline of the geology of the county with especial reference to the water-bearing strata. The present Memoir is the first of a series which the Director-General of the Survey proposes to issue, and there can be no doubt that the utility of the institution will be greatly enhanced by these publications.

"The Geology of the Borders of the Wash, including Boston and Hunstanton," is the title of another Memoir issued this year by the Geological Survey (price 3*s.*). It is the work of Mr. Whitaker and Mr. A. J. Jukes-Browne, with sundry notes by other officers who were engaged in the survey of the eastern counties. A large portion of the area described consists of the alluvial deposits of the Fenland, and there are considerable tracts of Chalk and Glacial drift. The most attractive geological features are those of the famous Red Chalk of Hunstanton, and of the picturesque scarps and warrens of Lower Greensand which border the Fenland, south of Hunstanton, through Snettisham, Dersingham, and Sandringham. The Lower Greensand is here divisible into three portions, of which the Carstone (or "gingerbread" stone) of Hunstanton forms the top, the Snettisham Clay the middle, and the Sandringham Sands the lower portion. Some important additions to our knowledge are contributed by Mr. G. W. Lamplugh, whose observations lead to the conclusion that the Carstone, as a whole, may represent the combined Hythe, Sandgate, and Folkestone Beds of the south of England; that the fauna of the Snettisham Clay agrees with that of the Tealby Limestone of Lincolnshire; while the Sandringham Sands appear to be newer than the Spilsby sandstone, and are presumably equivalent to some portion of the Tealby Clay. Particulars are given of the various divisions of the Chalk and of their fossils; and the appendix contains records of numerous wells and borings in Lincolnshire and Norfolk, and a supplementary geological bibliography of Norfolk.

A series of investigations, to determine the milling qualities of wheats and the nutritive value of flours, has been made by Mr. F. B. Guthrie, chemist to the Department of Agriculture of New South Wales, and special attention is directed to these in the report just issued by the Department. As the im-

mediate result of this work, the Department is in a position to pronounce definitely upon the milling quality of any variety of grain. In conjunction with the purely experimental work, Mr. Guthrie has been enabled to demonstrate the practicability of adjudicating upon wheats entered in prize competition on the basis of their flour product. The agricultural societies in the wheat districts have been so favourably impressed with the utility of the system that it is now customary for wheats, recommended by the judges employing ordinary methods, to be submitted to the milling test before the awards are made.

THE industry of viticulture promises to attain large proportions in New South Wales, the area in the Colony suitable for the production of grapes for wines of all types being practically unlimited. From the report just issued by the Department of Mines and Agriculture, we learn that the appointment of a graduate of one of the large viticultural colleges in Europe, to advise the vignerons as to the cultivation of the vine and the application of more scientific methods of wine production, has been much appreciated by those engaged in the industry. The phylloxera pest, which proved so disastrous a few years ago in Europe, and, unfortunately, appeared in New South Wales also, has received unremitting attention; and in the few places in which the insect has been discovered, the vineyards have been treated with carbon-bisulphide and rigorously uprooted. As a practical measure of protection against the inroads of this pest, the Department has secured from France half a million cuttings of phylloxera-resistant varieties for use as stocks in the planting of new vineyards.

A PRELIMINARY statistical statement of the mineral production of Canada during 1898 has been issued by the Canadian Geological Survey. The total value of the metallic minerals produced is placed at 21,622,601 dollars, while other mineral products have a value of 15,884,596 dollars. The grand total shows an increase of nearly 32 per cent. as compared with 1897, which year showed an increase of 27 per cent. compared with 1896. Whilst these large increases of late years have of course been partly due to the discovery and working of the rich gold-placers of the Yukon, other important mineral industries have also contributed to them, and there is every reason to expect a continued rapid growth in many of them for some years to come, especially as the province of British Columbia continues to develop.

THE "Year-Book and Record" of the Royal Geographical Society for 1899, which has just been published, contains portraits of the first President of the Society, Lord Goderich, and of the present President, Sir Clements R. Markham, K.C.B. The Society now numbers more than four thousand Fellows.

THE thirteenth part of Mr. Oswin A. J. Lee's brilliantly illustrated work, entitled "Among British Birds in their Nesting Haunts," has been published by Mr. David Douglas, Edinburgh. The nests illustrated in the ten plates are of the mistle thrush, great black-backed gull, red-backed shrike, skylark, buzzard, redstart, green woodpecker, linnet, and garden warbler.

THE *Bulletin of Miscellaneous Information* for January, issued by the Botanical Department of Trinidad, and edited by Mr. J. H. Hart, contains papers on the rubber, rice, cacao, and guinea-grass (*Panicum maximum*) industries of the island, and a continuation of the editor's enumeration and description of the Ferns of the West Indies and Guiana.

MR. W. L. DISTANT, the author of "A Naturalist in the Transvaal" and of several well-known entomological works, is about to issue a book called "Insecta Transvaaliensia," in twelve large quarto parts, with coloured plates. It will be mainly founded on the author's own collections and observations, and will be, to a large extent, an epitome of the South African insect fauna, and, we may presume, of the East African insect fauna in general, of which the South African is merely an offshoot.

AN estimate of the importance of electrical industries, and of the large number of people concerned with applied electricity, may be gained from two electrical trades' directories just issued. "*The Electrician* Electrical Trades' Directory and Handbook for 1899"—now in its seventeenth year of publication—testifies to the exceptional progress of the trades connected with applied electricity during the past year, the advance being not only in respect of electric illumination, but also of electric traction in its various forms and electric power supply generally. It has thus been necessary to largely extend the sheet tables of electric lighting and tramway undertakings in Great Britain. All the alphabetical sections have been carefully revised, and the tabular information has been checked. A feature of this handbook is a biographical section containing short biographies of distinguished physicists and electricians, many of them accompanied by half-tone portraits.—"The Universal Electrical Directory" contains the names of the members of the electrical and kindred industries throughout the world, the total number of names of firms and individuals included in it being 25,464. The natural expansion of the electrical industries has caused the addition of nearly two thousand new names to those contained in the volume for 1898. All the names are conveniently classified into nine sub-divisions, so that reference is easy. The volume is invaluable to all who are engaged in the commercial applications of electricity.

A NEW method of preparing Le Verrier's phosphorus suboxide, P_4O, is given by Messrs. A. Michaelis and M. Pitsch in the last number of the *Berichte*. If finely divided phosphorus is treated in the cold with a weak alcoholic solution of caustic soda or potash, it slowly gives off hydrogen, and the liquid becomes an intensely dark red colour. This red solution, when treated with acid, gives a greenish-yellow precipitate, which on analysis proved to be pure P_4O. This can be readily redissolved in weak alkali to a deep red solution, but it appears to be insoluble in all other solvents. As the authors remark, it is curious that the formation of this compound in this way should have so long escaped notice, as the preparation of hydrogen phosphide by the action of hot alcoholic potash upon phosphorus is one of every-day occurrence.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. H. Belier; two Black-backed Jackals (*Canis mesomelas*) from South Africa, presented by the Hon. James D. Logan, jun.; two Squirrels (*Sciurus vulgaris*), British, presented by Miss Dorothy Reynolds; two Nicobar Pigeons (*Calaenas nicobarica*) from the Indian Archipelago, presented by Mr. W. H. St. Quintin: a Reed Bunting (*Emberiza schoeniclus*), European, presented by Mr. F. Chatwin; a Broad-fronted Crocodile (*Osteoloemus tetraspis*) from West Africa, presented by Lieut. Kenneth A. Macdonald, A.S.C.; three Cape Vipers (*Causus rhombeatus*), a Puff Adder (*Bitis arietans*), a Rough-keeled Snake (*Dasypeltis scabra*) from South Africa, presented by Mr. S. B. Carlile; a Clouded Tiger (*Felis nebulosa*) from Northern India, four Waxwings (*Ampelis garrulus*), European; three Wandering Tree Ducks (*Dendrocygna arcuata*) from the East Indies, an Adorned Terrapin (*Chrysemys ornata*) from Central America, an Indian Eryx (*Eryx johni*) from India, purchased; a Macaque Monkey (*Macacus cynomolgus*), born in the Gardens.

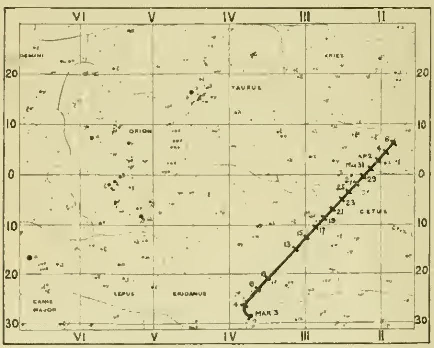
OUR ASTRONOMICAL COLUMN.

COMET 1899 *a* (SWIFT).—The following positions of the comet are taken from a circular received from the Centralstelle at Kiel:

Ephemeris for 12h. Berlin M.T.

1899.	R.A. h. m. s.	Decl. ° '	Br.
March 23	2 33 25	−5 7·4	
25	1 27 23	3 26·4	1·40
27	1 21 19	1 50·2	
29	1 15 8	−0 18·3	1·68
31	1 8 44	+1 10·1	
April 2	2 2 1	2 35·5	2·11
4	1 54 54	3 58·6	
6	1 47 19	+5 20·1	2·73

As will be seen from the table, the brightness is rapidly increasing as perihelion is approached; the possibility of observing the comet will depend on the local conditions of the sky near the horizon. It sets now about an hour after sunset. As a



guide for its recognition the accompanying chart of the region is given, which shows the path of the comet from the time of its discovery.

TUTTLE'S COMET.—Mr. J. Rahts continues his ephemeris of this comet in *Ast. Nach.*, Bd. 148, No. 3552. He also gives the elements for the epoch 1899 May 14·0 Berlin mean time.

Elements.

$$\left.\begin{array}{l} M = 359^\circ\ 59'\ 46''\cdot 7 \\ \pi = 116\ 29\ 3\cdot 0 \\ \Omega = 269\ 49\ 53\cdot 6 \\ i = 54\ 29\ 16\cdot 3 \end{array}\right\} 1900\cdot 0 \qquad \begin{array}{l} \phi = 55^\circ\ 15'\ 23''\cdot 7 \\ \mu = 259''\cdot 6234 \\ \log a = 0\cdot 7571085 \end{array}$$

It may be interesting to many to recall the past history of this comet. It was discovered by Tuttle at Cambridge, U.S.A., on January 4, 1858 (*Ast. Nach.*, No. 1125). Some time after it was recognised to be identical with the comet 1790 II., and its period determined to be about 13·7 years. Confirmation of this was provided by its return in 1871 and again in 1885, passing perihelion in the latter year on September 11 (J. Rahts, *Ast. Nach.*, No. 2700). It has again this year been observed in a position closely agreeing with that computed from the data obtained in 1885, so that the new values for its elements are probably very nearly correct.

VARIABLE STARS.—*Harvard College Observatory Circular* No. 41 deals with the results of the photometric measurement of the stars + 20° 4200 (U Vulpeculæ) and + 28° 3460 (S.T. Cygni), which were announced to be variable by Müller and Kempf (*Ast. Nach.*, Bd. 146, No. 37). The measures were made by Prof. O. C. Wendell with the photometer with achromatic prisms attached to the 15-inch equatorial. In his case the stars were directly compared with stars of known magnitude in their immediate vicinity, while at Potsdam each was compared with the standard by means of an artificial star, and this fact probably accounts for the greater accordance among the Harvard figures. Apart from this the smoothed curves of both observers agree fairly closely, as is shown in the plotted light curves given in the article.

The period of + 20° 4200 is 7·98 days, during which the magnitude varies from 6·9 to 7·6. The star + 28° 3460 has a period of 3·8 days, its magnitude changing from 6·55 to 7·36.

In the remaining part of the *Circular*, dealing with the variable S Antliæ, the remarkable accuracy attainable with the apparatus is well shown. This star has a period of 7h. 46·8m. (the shortest known except in the case of variables in clusters), and it was doubted whether its period ought to be doubled as was the case with U Pegasi. The differences in magnitude of S Antliæ at minimum and its comparison star for widely differing epochs only varied by ·004 of a magnitude, so that the period of variation as taken is correct, and the star is not of the same type as β Lyræ or U Pegasi.

RELATION OF EROS TO MARS.—In a short article in the *Astronomische Nachrichten*, Bd. 148, No. 3542, Herr J. Bauschinger, of the Berlin Observatory, points out the importance of the discovery of the minor planet Eros with reference to the relationship of Mars to the other planets. Hitherto Mars has been regarded as a major planet, and the asteroids as the remnant of a former planet existing between it and Jupiter. Since the recent observation of the new asteroid it is possible to regard Mars itself as having been included in the original planet which filled the gap, this view being supported by the facts of Mars having so small a mass and the great eccentricity of its orbit. If this turn out to be true, we shall in future have to speak of the "Planetoid-ring between the Earth and Jupiter" in discussing the asteroids.

MEASURING EXTREME TEMPERATURES.[1]

THE measurement of extreme temperatures is a subject of great theoretical interest, especially in connection with the determination of the laws of radiation and of chemical dissociation and combination. The temperature in each case is the factor of paramount importance, and without means of measuring the temperature there is no possibility of formulating any rational theories. The subject possesses, in addition, a powerful fascination for the experimentalist, on account of the difficulty of the observations involved, and of the extremely conflicting nature of the results obtained by different observers and different methods of research.

Temperature of the Sun.

Attempts have frequently been made to estimate the temperatures of the electric arc and of the sun, which may be taken as examples of the most extreme temperatures known to science, and afford an illustration of the difficulties to be encountered, and of the methods available for attacking these problems. A brief consideration and comparison of the results will also serve to explain the causes of the remarkable discrepancies existing in the estimates of such temperatures by different observers and different methods.

In the case of the sun it is at once obvious that no terrestrial thermometer can possibly be directly applied. The only available method is (1) to measure the intensity of the solar radiation, and (2) to endeavour to deduce the temperature by determining the law of radiation at high temperatures. The measurement of the intensity of the solar radiation is in itself a sufficiently intricate problem, containing many elements of doubt and difficulty; but by far the greatest source of uncertainty lies in the solution of the second part of the investigation, the determination of the law of radiation. The origin of the discrepancies thus imported into the results may be summed up in the word "Extrapolation."

The method of investigation necessarily consists in taking a series of observations at temperatures within the laboratory range of thermometry, from which to calculate an empirical

[1] Discourse delivered at the Royal Institution, on March 10, by Prof. H. L. Callendar, F.R.S.

formula representing as closely as possible the results of experiment. It is then assumed that the formula may be "extrapolated," or used to estimate the temperature of a radiating source of known intensity *beyond the range* of the observations on which it was founded. This is a perfectly justifiable method, and may lead to very good results if the empirical law happens to be correct; but if the formula happens to be unsuitable, it may lead to the most remarkable conclusions.

Law of Radiation.

The curves shown in Fig. 1 illustrate some of the typical formulæ which have either been proposed for the law of radiation, or been deduced from the results of modern experiments over the experimental range of the gas thermometer, extending to 1200° C., to which trustworthy determinations of temperature on the theoretical scale are at present restricted. In order to obtain a comparison of the formulæ themselves, apart from other issues, the results of different observers are reduced to a common hypothetical value, 10 watts per square centimetre, for the radiation from a black body at 1000° C.

Excluding the law of Newton, which applies only to small differences of temperature, and also the law of Dulong and Petit, which was founded on observations over a very limited range with mercury thermometers, and is obviously inapplicable at high temperatures, there is a certain family resemblance between the remaining curves; but the differences between them are still so considerable that, if sufficiently accurate measurements of temperature were available, it should be possible to decide with certainty which of the formulæ was the most correct. A fairly close agreement is seen to obtain between the formula proposed by Weber and the curves representing the results of the recent experiments of Bottomley, Paschen and Petavel. But, on the other hand, there is strong evidence, both experimental and theoretical, in favour of the fourth power law

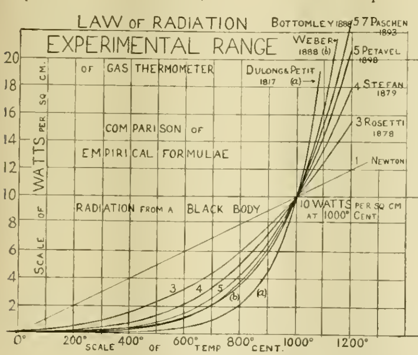


FIG. 1.—Formulæ of radiation. Experimental range.

proposed by Stefan, which differs materially from that of Weber; and many supporters may be found, especially among astronomers, for the very different formula of Rosetti.

Results of Extrapolation.

The importance of choosing a correct formula is most easily realised by reference to Fig. 2, which represents the results of extrapolation as applied to deducing the probable temperature of the sun. On the scale of Fig. 2, the dimensions of the experimental range of Fig. 1 are reduced to the thickness of the line at the lower left-hand corner of the diagram. The line at the top represents the intensity of solar radiation, which is taken at 10,000 watts per square centimetre in round numbers. The points at which the various curves meet this line show the corresponding values of the solar temperature.

The estimates of one million degrees and upwards, which were current in many of the older books on astronomy, were deduced from the law of Newton, and are obviously out of the question. The celebrated formula of Dulong and Petit gives results between 1500° and 2000° C., according to the data assumed, and evidently errs too much in the other direction. At the same time, it must be observed that the recent formula of Weber gives a result which is very little higher. Paschen considered that his results lent support to Weber's formula, and disagreed entirely with Bottomley's. But, according to the writer's reductions, they agree very closely with Bottomley's,

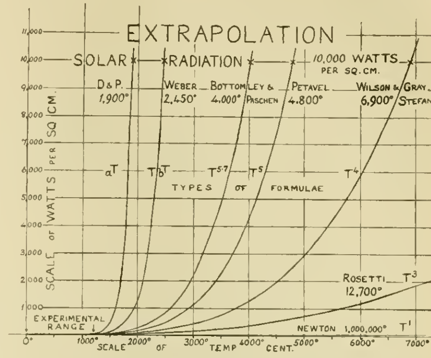


FIG. 2.—Temperature of the sun by extrapolation.

and are best represented by the formula $ET^{5.7}$. The experiments of Petavel agree most nearly with a fifth power law. On the other hand, the experiments of Wilson and Gray, in which the temperature was measured by the *expansion* of a platinum strip, instead of by the increase of its electrical resistance, appear to be in exact confirmation of the fourth power law of Stefan, and give a much higher result for the solar temperature. The formula of Rosetti is approximately a third power law at high temperatures, and would not be admitted as probable, at least by physicists, at the present time.

The various formulæ above mentioned, together with the methods employed and the results deduced, are summarised in the following table.

TABLE I.—*Law of Radiation.*

Observers and date.	Temperature measured by	Radiation observed by	Formula proposed.	Solar temp. deduced.
				° C.
Dulong and Petit (1817)	Mercury thermometer	Rate of cooling in vac.	$E_1\ 1{\cdot}0077^T$	1900
Rosetti (1878)	Mercury thermometer	Thermopile Sb-Bi	E_3T^3 (nearly)	12,700
Stefan (1878)	No experiments made.		E_4T^4	6900
Schleiermacher (1885)	Platinum resistance	Heat loss C^2R in vac.	E_4T^4	6900
Weber (1888)	No experiments made.		$E_2T\ 1{\cdot}00043^T$	2450
Bottomley (1888)	Platinum resistance	Heat loss C^2R in vac.	$E_6T^{5\cdot7}$ *	4000
Paschen (1893)	Thermo-couple Pt-Pt Rh	Bolometer	$E_6T^{5\cdot7}$ *	4000
Wilson and Gray (1897)	Platinum expansion	Radio-micrometer	E_4T^4	6900
Petavel (1898)	Platinum resistance	Bolometer	E_5T^5 *	4800

* Formulæ deduced by the writer from the observations.

The above table is not intended to be exhaustive, but merely as a comparison of typical formulæ, reduced to a common standard. It does not contain the results of photometric investigations.

The Necessity of More Accurate Measurements of Temperature.

The conclusion to be derived from the above illustrations appears to be that in order to arrive at any certain knowledge with regard to the law of radiation, and the measurement of such extreme temperatures as those of the arc, and of the sun, the first step must be to secure a higher order of accuracy in the

determination of the highest temperatures which can be observed and measured in the laboratory with material thermometers. There are other difficulties which are peculiar to the determination of the law of radiation, but we are at present concerned primarily with those relating to the measurement of temperature.

There are two comparatively independent lines along which research may proceed with advantage at the present time. (1) The direct comparison of different arbitrary methods; (2) the extension of the range of the gas-thermometer.

In order to secure consistency of statement and the reduction of the results of different observers to a common standard, it is in the first place desirable that the various methods available at the present time for the measurement of high temperatures in the laboratory should be *directly* compared *inter se*, through the greatest possible range. It is the custom at present for different observers to reduce their results *indirectly* to the scale of the gas-thermometer by reference to certain assumed values of the boiling and freezing points of various substances. They generally assume different values for these fixed points, and adopt different methods of calibration, which are undoubtedly responsible for many of the discrepancies at present existing.

To take an illustration from the experiments already quoted, the remarkable discrepancy between the experiments of Bottomley, Paschen and Petavel, on the one hand, and those of Wilson and Gray and Schleiermacher on the other, in the determination of the intensity of radiation from polished platinum, may be traced primarily to differences in the methods of measurement adopted. Bottomley and Petavel measured the electrical resistance of the radiating wire itself, and deduced the temperature by the usual formula for the platinum scale. Paschen calibrated his thermo-couple by reference to numerous fusing and boiling points. Wilson and Gray adopted the meldometer method based on the expansion of platinum, which they found to be uniform. The vacuum in Schleiermacher's experiments could not be measured, and was probably vitiated by gas evolved from the heated platinum.

"*Platinum*" *Methods of Pyrometry.*

These and similar discrepancies might be in a great measure removed, so far as they depend on the measurement of temperature, by the direct comparison of the various methods of measurement. The "platinum" methods are among the most important and the most easily comparable by direct experiment. These methods are founded on the characteristic stability and infusibility of the metals of the platinum group, properties which are accompanied by an even more remarkable degree of constancy in their less obvious electrical attributes. The two older methods, based on (1) the expansion and (2) the specific heat of platinum, are of comparatively limited application, but have given very good results in the able hands of Joly and Violle. The more modern electrical methods have the advantage of much wider applicability and convenience. They are of two distinct kinds: (3) the thermo-electric method, represented by the Pt-Pd. thermo-couple of Becquerel, the Pt-Ir. thermo-couple of Barus, and the Pt-Rh. thermocouple of Le Chatelier, and (4) the platinum resistance pyrometer of Siemens. The third method has been naturalised in this country, and brought to great perfection by the work of Sir William Roberts-Austen. The fourth method was that adopted by Bottomley, Schleiermacher, and Petavel in the experiments above mentioned, and has been applied with great success by Heycock and Neville at high temperatures, and by Dewar and Fleming at the other extremity of the scale.

Method of Indirect Comparison.

The usual or indirect comparison of the foregoing methods by means of the fusing points of various metals is illustrated in the annexed table, which contains several of the most recent results. The numbers given in brackets are now published for the first time, and should be regarded as preliminary.

TABLE II. *Fusing Points by "Platinum" Methods.*

Method.	Observers.	Silver	Gold.	Copper.	Palladium	Platinum.
(1) Expansion.	(C & E)	(945)	(1061)	(1085)	(1640)	(1980)
(2) Spec. heat.	Violle (1879)	957	1045	1054	1500°	1775
(3) Thermo-couples.	Becquerel (1863)	960	1092	[illegible]		
	Barus (1892)	985	[illegible]	1097	1643	1855
	,, (1894)	[illegible]	1091	1096	1585	1757
	Holborn & Wien (1895)	968	1072	1082	1587	1780
(4) Resistance.	H. & N. (1895)	961	1061	1082	(1550)	(1820)

The results above given for the expansion method (1) were obtained by assuming the expansion to be uniform, and taking the F.P. of gold as 1061°. The results of Violle by the specific heat method (2) were deduced by assuming a linear formula for the specific heat of platinum. The discrepancies of the various results obtained by the thermo-electric method (3) are partly due to errors of observation, and partly to extrapolation, *i.e.* to differences in the formulæ of reduction. The high value found by Becquerel for the F.P. of copper as compared with gold and silver is probably to be explained by the use of a much thicker wire in the case of copper. The very accurate and consistent experiments of Heycock and Neville leave little doubt that the F.P. of pure copper is at least 20° above that of gold. The much smaller difference of 4° to 5°, given by Barus, may possibly be explained by contamination with oxygen or other impurity. In the case of silver and gold, Messrs. Holborn and Wien adopted the Becquerel method of observing the fusion of fine wires. In the case of copper, they adopted the much more accurate method of observing the freezing point of a large mass of metal in a crucible, which had been employed by the writer in 1892, and was used by Heycock and Neville throughout their researches. The Becquerel method is very liable to give results which are too high.

The determination of the higher fusing points of palladium and platinum is necessarily attended with greater uncertainty because it involves extrapolation, and is therefore more dependent on the particular formula of reduction assumed, in addition to the experimental difficulties of the higher temperatures. Considering all the obstacles to be encountered, it would be unreasonable to expect such different methods to give any closer agreement at these points.

Advantages of Direct Comparison.

Whatever the origin of these discrepancies, there can be no question that they greatly retard the progress of research and discovery at high temperatures. With the object of helping to remove these obstacles, the writer has recently been engaged, in conjunction with Mr. Eumorfopoulos, in a direct comparison of methods (1), (3) and (4), which are the simplest and most generally applicable. The advantages of the direct method of comparison are very great. (1) The comparison may be extended continuously throughout the scale, and is not confined to a few arbitrarily selected points. (2) It is easy to apply the electric method of heating, which is of all methods the most easily regulated. (3) It is easy to arrange the experiments in such a way that there can be no question of difference of temperature between the thermometers under comparison, which is the most insidious source of error in high temperature measurement.

Comparison of the Expansion and Resistance Scales.

In the comparison of the scale of the expansion of platinum (1), with that of the platinum resistance thermometer (4), it is simply necessary to observe simultaneously the expansion and the electric resistance of a platinum strip, tube or wire maintained at a steady temperature by means of an electric current. The expansion may be measured, as in the meldometer of Joly, by means of a micrometer screw; but for lecture purposes it is preferable to adopt the method of the optical lever employed by Laplace in his experiments on expansion a century ago. By employing a direct reading ohmmeter to indicate the changes of electrical resistance, it is thus possible to exhibit the difference between the two methods by the simultaneous advance of two spots of light on a single scale. If the two instruments are adjusted to read correctly at 0° and 1000 C., the resistance thermometer will be in advance at temperatures below 1000°, but will lag behind at higher temperatures, because the rate of expansion increases as the temperature rises, whereas the rate of change of resistance diminishes. As the result of these experiments, it appears that the two scales (1) and (4) differ from that of the gas-thermometer to a nearly equal extent, but in opposite directions.

The resistance of platinum at its melting point is more than six times as great as at 0° C., whereas the whole expansion amounts to only one-fiftieth part of the length. The electrical method is for this reason by far the most accurate and sensitive. It also possesses in a very striking degree the merit of pliability and adaptability to the needs of each particular problem. For this reason the scale of the platinum resistance thermometer has

come to be regarded as the platinum scale *par excellence*, and has been adopted as the standard of reference in many recent researches.

Fusing Point of Platinum.

As an illustration of the facility of applying this method, the determination of the fusing point of platinum on the platinum scale may be taken. This is a difficult experiment to perform by any other method. In performing the experiment by the measurement of the electrical resistance, it suffices to take a fine wire of which the electrical constants are accurately known, and to raise it gradually to its melting point by steadily increasing the current. The observation of the resistance of the central portions of the wire at the moment of fusion gives directly the temperature required on the platinum scale. In attempting to perform the same experiment by the expansion method, we are met by the difficulty that the platinum begins to soften and stretch at a temperature considerably below its melting point. Owing to the smallness of the expansion, a very slight viscous extension produces a relatively large error. In the resistance method it is not necessary to subject the wire to tension, and a small strain would in any case produce an inappreciable error on account of the very large increase of resistance with temperature. To obtain an equal degree of accuracy by the calorimetric method (2), or the thermo-electric method (3), it is necessary to use a furnace in which relatively large quantities of platinum can be melted. This has been done by Violle for method (2), and by Barus and Holborn and Wien for method (3). The latter used a linear formula for extrapolation, although their gas-thermometer experiments appeared to indicate a cubic formula for temperatures below 1200° C.

The temperature of the melting point of platinum on the platinum scale by the resistance method (4) is approximately $pt = 1350°$, and varies but slightly for different specimens of platinum. The result when reduced to the scale of the gas-thermometer by assuming that the rate of increase of resistance diminishes uniformly with rise of temperature (according to the usual formula of platinum thermometry, which has been verified with great care at moderate temperatures) gives a temperature of 1820° C. on the scale of the gas-thermometer. It is not improbable that platinum may deviate slightly from this formula at the extreme limit of the scale in the close neighbourhood of its melting point, but the evidence for this result is at least as good as that obtainable by any of the other methods. The observations are very easy and accurate as compared with the calorimetric method, and it is not necessary to make any arbitrary assumptions with regard to the formula of reduction, as in the case of the thermo-electric method.

As the accuracy of this formula has recently been called in question, on what appears to be insufficient grounds, by certain German and French observers, it is the more interesting at the present time to show that it leads to a result which cannot be regarded as improbable at the extreme limit of the scale. A different formula has recently been employed by Holborn and Wien, and supported by Dickson (*Phil. Mag.*, December 1897). The writer has already given reasons (*Phil. Mag.*, February 1899) for regarding this formula as inferior to the original, of which, however, it is a very close imitation. The above observations on the melting point of platinum, if reduced by Dickson's formula, would give a result $t = 1636°$ C., which appears to be undoubtedly too low as compared with the results of other methods, however great the margin of uncertainty we are prepared to admit in these difficult and debatable regions of temperature measurement.

It should be observed that the results of Violle by method (2) are consistently lower than those given by the resistance method in the case of silver, gold and copper. We should, therefore, expect a difference in the same direction at the F.P. of Pt. as found by method (4), and not a difference in the opposite direction as given by the thermo-electric method, on the arbitrary assumption of a different type of formula for extrapolation at high temperatures. It is a matter of some interest that the assumption of linear formulæ for both the specific heat and the rate of change of resistance should lead to results so nearly consistent over so wide a range of temperature in the case of platinum.

Comparison of the Thermo-couple and the Platinum Thermometer, (3) *and* (4).

The chief difficulty and uncertainty encountered by Paschen in his experiments on radiation, was that of arranging the thermo-couple so as to be at the same temperature as the radiating strip of platinum. It is better for this reason to measure the temperature of the strip itself by means of its electrical resistance, the method adopted by Schleiermacher, Bottomley and Petavel. The same difficulty occurs in the direct comparison of the scales of the thermo-couple and the platinum resistance thermometer. The simplest method of avoiding this objection appears to be that recently adopted by the writer, of enclosing the thermo-couple completely in a thin tube of platinum, which itself forms the resistance thermometer. There can then be no question of difference of temperature between the two, and the same tube may serve simultaneously for the expansion method, and as a radiating source for bolometric investigation of the law of radiation. The uniformity of temperature throughout the length of the tube can be tested at any time by means of potential leads, or by shifting the thermo-couple to different positions along its length. The method of electric heating is employed, and the central portion only of the tube is utilised in the comparison.

(To be continued.)

THE ORBIT OF THE LEONID METEOR SWARM.[1]

THE great Leonid swarm of meteors consists of ortho-Leonids which pursue nearly the same path round the sun, and clino-Leonids which move in orbits sensibly differing from the ortho-orbit. The present investigation is concerned with the ortho-Leonids. They form a dense stream extended along a portion of an immense orbit round which they travel in 33¼ years. This orbit has its perihelion a little inside the Earth's orbit, and its aphelion a little outside the orbit of Uranus. It intersects the orbits of these two planets, but lies in a plane inclined to the ecliptic, so that the meteors which traverse it pass under the intervening planets on their outward journey and over them on the homeward journey.

Accordingly, the orbits of the intervening planets—Mars, Jupiter and Saturn—pass through the orbit of the meteors; and they, as well as Uranus and the Earth, whose orbits intersect it, and Venus, which lies but little beyond, are well situated for exercising a perturbating control over the motions of the Leonids. But the influence of Mars and Venus is inconspicuous, and that of the Earth only sensible on the meteors which pass close to it; so that nearly the whole of the perturbating effect upon the greater part of the swarm is due to Jupiter, Saturn and Uranus.

The procession of ortho-Leonids is so long that it takes between two and three years to pass each point of its orbit; and accordingly when it streams across the earth's path, which it does three times in a century, the earth has time to come round to the point of intersection in at least two successive years, and on each such occasion receives one of the greater Leonid showers—a splendid spectacle, but of such brief duration, lasting only a few hours, that it is visible only from the side of the Earth, which happens at the time to be its advancing side.

The first of these great displays recorded in modern times was that witnessed by Humboldt and Bonpland on the morning of November 12, 1799, when travelling in South America. It was quite unexpected. So was the next great shower which visited Europe on the morning of November 13, 1832, and was followed by a still greater display which was seen from numberless stations in America in 1833. This recurrence of the phenomenon after an interval of 33 years led to its being expected in 1866, and diligent preparations were accordingly then made by astronomers to avail themselves of the opportunity of acquiring more information about the mysterious visitants. These meritorious efforts resulted in a great accession to our knowledge. Prof. Hubert A. Newton collected the records of several ancient observations which showed that the swarm returns to the Earth at intervals of 33¼ years, and that the date on which the meteors are seen had advanced by 3½ weeks since A.D. 902. From their periodic recurrence, he found that they must be moving in one or other of five orbits which he described, and from the advance in the date he inferred that the longitude of the node of the orbit has been advancing, an effect which must be due to perturbations. Prof. Adams ascertained which of Newton's five orbits is

[1] "Perturbation of the Leonids." By G. Johnstone Stoney, M.A., D.Sc., F.R.S., and A. M. W. Downing, M.A., D.Sc., F.R.S. (Abstract of a paper read before the Royal Society on March 2.)

the real one. Schiaparelli detected the dynamical explanation of the fact that the swarm is lengthened out like a stream along a portion of Adams's orbit. And Leverrier adduced evidence that the Leonids have been less than eighteen centuries within the solar system: that in fact they were diverted into their present eiliptic orbit at the end of February or beginning of March in the year A.D. 126, in consequence of having then passed, while still a compact cluster, close to the planet Uranus. Adams further pointed out that there is a comet moving nearly in their track.

These were great achievements; of which the most noteworthy is the great discovery made by Prof. Adams when he determined definitely the real orbit in which these bodies move. This he accomplished by computing the perturbations which would be suffered in each of the five possible orbits, and comparing the calculated amount of the shift of the nodes with that which had been obtained by comparing the ancient with recent observations..

The main swarm of Leonids is again returning. A shower of several hundreds of meteors, produced by the extreme front of the ortho-stream, was observed last November in America. Still greater showers may be expected this year and next year, and perhaps a considerable display in the year following; and it is eminently desirable that this opportunity of increasing our knowledge in this entirely new branch of astronomy shall not be lost. It is the second occasion when astronomers have been able to foresee when the opportunity is about to present itself.

In 1866, the great object was to ascertain the orbit. To determine this, what was wanted was the average amount of the perturbations, and it was this average which Adams computed. But to make a further advance—to explore more fully the past history of the Leonids, or their present condition, or to predict the future—a more intimate acquaintance with the perturbations is essential. Now perturbations reach each meteor individually. They differ from one revolution to another, and within each revolution they variously affect the meteors that occupy different stations along the stream.

The present investigation was entered on as a commencement of the more searching inquiry indicated above. The stream is regarded as divided into segments of such moderate length that the perturbations which operate on the meteors occupying any one of them may be regarded as sensibly the same. One of these segments is selected—that through which the Earth passed in 1866—and the actual perturbations to which the elements of its orbit are being subjected throughout an entire revolution, have been computed by the method of mechanical quadratures. The revolution extends from 1866 November 13, when the Earth passed through this segment of the stream, till 1900 January 27, when the same segment will return to the intersection of the meteoric orbit with the Earth's orbit.

The inquiry has already led to remarkable results. During this revolution an entirely abnormal amount of perturbation has acted on the meteors in the selected segment of the stream. This perturbation has been produced chiefly by the attraction exercised by the great planets Jupiter and Saturn, and its unusual amount has been occasioned by a near approach of Saturn when that segment of the stream, for which the calculations were made, was on its outward journey, and a still more close approach of Jupiter, when the meteors were on their homeward journey. These events have resulted in such a perturbation of the orbit, that the shift of its node during this revolution has had more than $3\frac{1}{2}$ times its average amount, and that the periodic time has become augmented by as much as $\frac{1}{4}$ of a year.

This last perturbation will have a remarkable effect on the future history of this segment of the stream, unless it is compensated by what occurs elsewhere or in subsequent revolutions. It indicates, too, that whatever portion of the stream has been most perturbed in this revolution is falling back towards the parts behind and retreating from the portions in front; thus introducing a new inequality of distribution of density along the stream, superadded upon whatever inequalities of a like kind may have existed previously. Thus some parts of the stream are becoming unduly crowded with meteors. Others of the perturbations indicate that in this remarkable revolution a new sinuosity of sensible amount is being set up in the stream. These effects have been made conspicuous by the fortunate circumstance that the revolution for which the calculations have been made has happened to be one in which the perturbing forces have attained an intensity far exceeding the average.

The information supplied by this inquiry in regard to the time when the Leonid shower of next November may be expected is considerable, but far from complete. It may be stated as follows:—At the epoch 1899, November 15, the longitude of the node of the orbit for which the calculations have been made will be 53° 41′ 7, a position which the earth will reach on 1899 November 15d. 18h. It is probable, therefore, that the middle of the shower of the present year (1899) will occur nearly at this time, since the segment of the stream, for which our calculations have been made, is situated in the stream less than three months' journey of the meteors behind the segment which the Earth will encounter next November. This conclusion, however, rests on two assumptions: (1) That the two segments were, in 1866, moving in orbits that did not much differ; (2) That the perturbations which these segments have since suffered have not much differed. Both assumptions are probable, but unfortunately neither is certain; so that the prediction can only be offered with reservation. If the shower occurs at the time anticipated, it will be visible from both Europe and America.

A NEW PHOTOGRAPHIC PRINTING PAPER.

WITHIN the last few months several new brands of photographic printing papers have been placed on the market, all of which are characterised by the possibility of all the manipulations involved in the exposure and development of the prints being performed in an ordinarily lighted room. The basis of most of these papers is a very slow bromide emulsion, with varying proportions of chlorides to modify its qualities for particular purposes. The paper issued under the name of "Dekko" by Messrs. Kodak, Ltd. (late the "Eastman Photo. Materials Co."), is one of this class. As stated in the circulars accompanying the paper, its special feature is that it may be exposed, developed and fixed in an ordinary room illuminated by artificial light or weak daylight, thus doing away with the necessity of a special dark room for its treatment.

The paper may be safely handled for placing in the printing frame and developing at a distance of 8 or 10 feet from an ordinary full gas flame, or nearer if the light be turned down. With the Welsbach light or daylight it is advisable to shade the light with one thickness of orange paper.

For exposure the instructions recommend from three to five minutes at a distance of 6 or 8 inches from an ordinary gas burner for a negative of medium density. For daylight from one to two seconds at 2 feet from the shaded window will be sufficient. In this connection, however, we would urge the convenience and certainty with which these contact prints may be made by exposure to the light of burning magnesium. The light given is extremely actinic, as is at once appreciated if its spectrum be examined: it is more portable than any other illuminant, and may consequently be used where others are quite inaccessible, and as the metal in the form of ribbon is fairly pure, the light evolved from the combustion of a given length is practically constant.

The development of the paper is similar to that of ordinary bromide paper, except that the process is much quicker, full density being obtained in at most thirty seconds. The formula recommended for ordinary black tones is a mixture of hydroquinone and metol. The paper, however, lends itself readily to the production of varied tones from brown to bright red, these being obtained by variations both of exposure and developer. A special developer for warm tones is given in the printed instructions.

Fixing is carried out in the usual manner, and the prints should be washed for at least an hour, after which they are ready for mounting.

This paper will prove a useful addition to the printing papers already on the market; its simplicity of working and long range of colours obtainable recommending it for the amateur, while the professional will find it of great service for producing quantities of permanent prints of uniform appearance at any season of the year.

LOCAL AUTHORITIES FOR SCIENCE AND ART INSTRUCTION.

THE Directory issued by the Department of Science and Art in 1897, contained a section which has since become widely known, and will probably take a prominent place in educational politics for some time. The new paragraph—referred to as Clause

vii.—reads as follows: "In counties and county boroughs in England which possess an organisation for the promotion of secondary education, such organisation, if recognised by the Department, may notify its willingness to be responsible to the Department for the science and art instruction within its area. In such case grants will in general be made to the managers of new schools and classes, only if they are acting in unison with such organisation. The rights of the managers of existing schools and classes will not be interfered with; and Town Councils and School Boards which are managers of schools re-receiving Science and Art grants will not be debarred from establishing in their districts additional schools where necessary. In Wales the Intermediate Education Authority is for this purpose regarded as the authority for the promotion of secondary education." Clause vii. was repeated in the Directory for 1898, and has, since its introduction, been the cause of considerable discussion.

The following is a complete list of those local authorities which have up to the present been accepted by the Science and Art Department as responsible for the science and art instruction within their respective areas:—

COUNTIES.

Cambridgeshire	Northumberland
Cumberland	Nottinghamshire
Derbyshire	Oxfordshire
Dorset	Somerset
Durham	Staffordshire
Essex	Suffolk (East)
Hampshire	Surrey
Herefordshire	Sussex (East)
Lancashire	Sussex (West)
Leicestershire	Westmorland
Middlesex	Wiltshire
Norfolk	Yorkshire (West Riding)

COUNTY BOROUGHS.

Bath	Oxford
Bolton	St. Helens
Brighton	West Bromwich
Burnley	Worcester
Devonport	

Just recently the application made by the London County Council to be recognised as responsible within the County of London, for the instruction in subjects sanctioned by the Department of Science and Art, has been granted.

Before referring to the opposition which has been offered by educational organisations (other than those ultimately authorised by the Department to act under Clause vii.) to an acceptance of the claims of the public body applying for recognition, it will be advisable to call attention to certain utterances of the President and Vice-President of the Committee of Council on Education, since their remarks have served to define more clearly the scope of the new clause. His Grace the Duke of Devonshire has said "he was perfectly aware that considerable jealousy had been felt of these organisations (under Clause vii.), because it was supposed that, if largely adopted, they would probably be stereotyped hereafter by legislation as the future educational authority. He did not believe there was any ground for such jealousy or suspicion. The Government was perfectly aware that the creation of strong bodies for the control of secondary education must be the work of Parliament . . . and when the time came the Government had no intention of shrinking from making their own proposals."

Such an utterance as this should go a long way towards dispelling any idea that Clause vii. is an attempt "to carry out the recommendation of the Secondary Education Committee without legislation." At a conference in June last, between the Department of Science and Art and the Organising Secretaries and other representatives of the then recognised authorities, Sir John Gorst explained that "the accepted organisations would (1) receive *en bloc* the grants earned in all schools in their areas; (2) be given power to appoint teachers in science subjects, who would not be required to possess the special qualifications laid down in the Directory; and that the work of examination and inspection would remain in the hands of the Department. It was also decided at the same conference that such local authorities should settle questions relating to the managers of different schools and their duties, and should receive examination results direct from the Department.

The opposition offered by the London School Board to the claim of the London County Council referred to above, led to an inquiry by the Department of Science and Art, and the several points raised by the School Board may be fairly taken as typical of the objections to the clause throughout the country. Amongst other matters the School Board urged that the present policy of the Department was to look upon the managers of elementary schools engaged upon higher work as intruders, and that this was inconsistent with the ideas which led to the establishment of the Department. It was argued that the granting of authority to the London County Council would be an improper prejudicing of the function of Parliament, and would be unconstitutional; and also that Clause vii. in operation might seriously prejudice the rights of volunteers in evening continuation science and art work, inasmuch as the County Council would under the clause have the right of vetoing what they considered to be unnecessary evening continuation work.

Such is briefly the present state of affairs. The Department of Science and Art continues to judge each application received from local educational committees, of one kind or another, upon its own particular merits, and the decision of the Department is final. The extent to which the powers of South Kensington under Clause vii. may be modified by legislation—which appears to be imminent—remains to be seen. Time alone might perchance suffice to reconcile the objectors.

A. T. SIMMONS.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following is the speech delivered by the Public Orator, Dr. Sandys, Fellow and Tutor of St John's, in presenting for the complete degree of M.A. *honoris causâ* Mr. G. Sims Woodhead, Professor of Pathology:—

"Duos deinceps pathologiae professores, fere in medio aetatis cursu morte immaturâ praereptos, non sine dolore nuper amisimus, quorum utriusque egregia in Academiam merita non est quod longius exsequar: vosmet ipsi vobiscum non sine desiderio recordamini. Hodie vero professorem talium virorum in locum nuperrime electum, morâ nullâ interpositâ salutamus, et senatus nostri in ordinem statim cooptamus. Abhinc annos viginti regiae societati medicae inter Edinenses praepositus, postea ibidem uno in quinquennio discipulorum duo milia pathologiae praeceptis imbuisse dicitur. Idem et olim inter Berolinenses et nuper inter Londinenses maximo cum fructu his studiis operam dedisse fertur. Peritis quidem nota sunt volumina illa quae (ne alia commemorem) de pathologiae praesertim scientiâ conscripsit. Ab isdem non sine spe magnâ expectatur opus ingens, in quo de remedio novo contra diphtheriae toxicum nuper feliciter adhibito, aegrotantium numero immenso recensito, accuratissime disputat. Sunt etiam alia professoris nostri in studiis generi humano salutaria, quae memoratu sunt dignissima; sed hodie haec omnia, temporis iniquo exclusus spatio, ut Vergili verbis utar,

"'praetereo, atque aliis post me memoranda relinquo.'

"Duco ad vos Professorem WOODHEAD."

DR. THOMAS BARLOW has been appointed to fill the vacancy in the body of the University of London Commissioners caused by the resignation of Sir William Roberts.

Science announces the following recent gifts to educational institutions in the United States:—Washington University, St. Louis, has just received generous gifts enabling it to remove to its new site facing Forest Park. This site was purchased with a fund of 200,000 dollars, contributed by seventy-five different subscribers. Funds for a library, to cost 100,000 dollars, are in the hands of the directors by the bequest of the late Stephen Ridgley. The additional buildings include an engineering building, costing 150,000 dollars, given by Mr. Samuel Cupples, and a chemistry building, costing 100,000 dollars, given by Mr. Adolphus Busch. Mr. Brookings has also offered 100,000 dollars, on condition that 500,000 dollars be subscribed at once for an endowment.—Mr. Philip D. Armour has given 750,000 dollars to the Armour Institute of Chicago, which he had previously endowed with 1,500,000 dollars.—The will of the late Alexander M. Proudfit, of New York City, gives 30,000 dollars to Columbia University for two fellowships, one in letters, and one for advanced studies in medicine.—Knox College,

at Galesburg, Ill., has collected a fund of 100,000 dollars, thus securing the additional gift of 25,000 dollars made by Dr. D. K. Pearsons.—Efforts are being made to persuade President Taylor not to leave Vassar College for Brown University. With this end in view, a meeting of the Alumni decided to try to collect the sum of 2,000,000 dollars for the endowment of Vassar.

AN address by Prof. S. W. Holman on "The Function of the Laboratory," published in *The Technology Review*—a quarterly magazine relating to the Massaschusetts Institute of Technology—is of interest in connection with the discussion which has lately taken place in these columns as to the relation between polytechnic institutions and industrial chemistry. Prof. Holman points out that the man whose occupation is exclusively the practice of an art (other than the fine arts) is an artisan, not a member of the technical professions. The work of the technical professions is the direction and extension of the application of the arts, together with a far higher function—the development of the arts, that is, of technology. Prof. Holman's view is that the chief function of the engineer is to bring pure and applied science to the industrial service of mankind. It is for him to analyse the ever new industrial problems, bringing to bear upon them the scientific method of inquiry, and applying to their solution all related scientific as well as technical knowledge. And what is true of the engineer is equally true of the members of the other technical professions. Moreover, modern technical practice is progressing with such acceleration, and every branch of scientific knowledge is so diffusing itself into every line of engineering, that the coming generation of engineers will find the most thorough command of science which they can obtain a none too efficient aid in the keen competition of their future practice. Breadth of view, opportunity, ingenuity, and "common sense" being equal, he who is a master of science will distance competitors. Science, then, and its methods must rank first; applied science, second; artisan skill, last.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, February.—Prof. F. N. Cole gives an account of the fifth annual meeting of the Society, and abstracts several of the papers which were read. It appears that this young Society is in a very flourishing condition. Prof. Cole stated that two factors have contributed powerfully to increase the Society since its reorganisation as a national body (originally it was the New York Mathematical Society). One of these is the institution of summer meetings, held usually in connection with the large general scientific gatherings; and the other is the founding of the Chicago Section, which works in perfect harmony with the general Society.—Prof. Holgate follows with an account of the December meeting of this Chicago branch.—Some thirteen papers were read, and a few of these are given in abstract.—A valuable "report on recent progress in the theory of the groups of a finite order" is a paper by Dr. G. A. Miller, a well-known authority in this field of work. It was read at the meeting of the American Association, held at Boston in August last. The period considered extends over the last ten years, and a full list of works is given. These are considered under the heads of (1) Soluble groups, (2) Simple groups, (3) Substitution groups, (4) Abstract groups, and winds up with a general conclusion. The author's aim has been to call attention to only a few of the important recent advances in the theory. The same gentleman adds a short note on Burnside's "Theory of Groups."—Prof. F. Morley contributes a short article on a regular configuration of ten line pairs conjugate as to a quadric. This note, which was read before the Society in October, is an addendum to the same author's account of the model laid before the London Mathematical Society in June last (*Proc. L.M.S.*, vol. xxix).—A few short reviews follow: Einleitung in die Theorie der Bessels'chen Funktionen, by Prof. Graf and Dr. Gubler; Leçons de Cosmographie, by MM. F. Tisserand and H. Andoyer; Lectures on Elementary Mathematics, by J. L. Lagrange (McCormack's translation); &c. An account is given of the new publication, *L'enseignement Mathématique*, edited by MM. Laisant and Fehr. Its object is to contribute to the improvement of mathematical instruction by making more widely known its organisation in different countries, by discussing methods of teaching, &c.—Prof. Greenhill contributes a long and excellent review of Prof. Appell's éléments d'analyse mathématique.—Dr. Lovett has a full budget of *Notes*, and there is a good list of new publications.

IN the *Journal of Botany* for March is an interesting paper, by Mr. B. Daydon Jackson: on a review of Latin terms used in botany to denote colour. Mr. Jackson enumerates all the terms used by Latin writers, with their different shades of meaning, classifying them under twelve heads, viz. (1) terms implying absence of colour; (2) white; (3) grey (cold neutrals); (4) black; (5) brown (warm neutrals); (6) red; (7) orange; (8) yellow; (9) green; (10) blue; (11) purple; (12) terms implying colour without defining it, and vague terms. A useful bibliography is appended.

Bollettino della Società Sismologica Italiana, vol. iv., 1898, No. 7.—The earthquake of Hayti (West Indies), in the morning of December 29, 1897, by G. Agamennone.—On the form of the slow oscillations in earthquakes, by G. Grablovitz. Argues that the records furnished by pendulums are to be attributed to the composition of the effects produced in them by horizontal motions and tilts of the ground, and not exclusively by either.—List of earthquakes observed in Greece during the year 1895 (July to December), by S. A. Papavasiliou, the total number being about 260 (of which 105 were observed in the island of Zante), *i.e.* about one and a half per day.

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, March 2.—Dr. A. Günther, F.R.S., President in the chair.—Mr. H. M. Bernard showed some microscopic sections of the digestive cæca of spiders, which had led him to the conclusion that digestive, assimilatory, and excretory functions are all performed by these.—Mr. J. E. Harting exhibited a male specimen of the rare King Eider (*Somateria spectabilis*) which had recently been forwarded in the flesh from Lerwick, and called attention to the colours of the soft parts, which differed materially from the colours represented by Gould in his folio plate of this species. After referring to the natural haunts of this duck in the Palæarctic and Nearctic regions, he described it as a bird of such rarity in the British Islands that since it was first noticed as a visitor to the coast of Norfolk in 1813, not more than a score of examples had been met with, the last of which was reported in November 1890.—The President referred to the statement of Colonel Montagu, made on the authority of Bullock, that the King Eider had nested in Papa Westra, an observation which had not been confirmed; and Mr. H. Druce made some remarks on the process of bleaching to which the eider-down of commerce is generally, though not always, subjected.—Mr. G. C. Druce exhibited and made remarks on specimens of *Dianthus gallica* from Jersey. Mr. W. P. Pycraft read a paper on the external nares of the cormorant, intended to supplement a communication on the same subject made some years ago by Prof. J. C. Ewart (*Linn. Soc. Journ.*, *Zool.*, xv., 1881, p. 455). Mr. Pycraft found in every species of cormorant which he had examined that the external nostril lies without and below the rhinothecal groove, and not at its end as had been previously described. He had failed in every case to pass even the finest bristle up this groove into the nasal cavity. In the gannets (*Sula*) he had not been able to find any trace of this nasal groove or aperture. Further remarks were made by the President, Prof. Howes, and Mr. Harting, chiefly in regard to the bearings of the facts on correlation of structure with habit.—Mr. G. C. Druce read a paper on the reported occurrence in Ireland of *Carex rhynchophysa*, and gave reasons for believing that *Carex rostrata* var. *latifolia* had been mistaken for it. Typical specimens of both were exhibited, and also a coloured drawing by Mr. N. E. Brown of one of the plants collected by Mr. Lloyd Praeger, near Mullaghmore Lough, Armagh. Some further remarks were made by Mr. C. B. Clarke, more especially with reference to the descriptions of plants believed to be new to British flora. Mr. Edward Step, read a paper on the fertilisation of *Glaux maritima*. After examining some hundreds of flowers gathered along the coast near Portscatho, Cornwall, he had come to the conclusion that the flower is protogynous. When open, the calyx-lobes at first separate but slightly, affording only a narrow entrance. The curvature of the style is sufficient to bring it within the fold of a calyx lobe, from which the stigma projects so as to be in the way of any insect that visits the flower for the liquid that exudes

from the ovary and base of the style. When the yellow pollen is shed, the style is either quite erect, or retains its original bend sufficiently above the anthers to make self-fertilisation probable. Owing to the lowly habit of the plant and its customary crowding in with sea-sedge and grasses, it is not an easy one to watch. Doubtless it is often fertilised with its own pollen by the agency of flies and other insects; but from the position and precocity of the stigma, Mr. Step considered that cross-fertilisation is quite as frequent. He was consequently unable to agree with Mr. Henslow (*Trans. Linn. Soc.*, n. s. *Bot.* i. 1880. p. 377, pl. 44, fig. 35) as to self-fertilisation in this plant, believing his conclusion to have been drawn from the examination of an abnormal specimen.

Zoological Society, March 7.—Prof. G. B. Howes, F.R.S., Vice-President, in the chair.—Mr. J. E. S. Moore exhibited and made remarks upon specimens of the Medusa (*Limnocnida tanganjicae*) of Lake Tanganyika, which he had obtained during his recent expedition to that lake.—Mr. R. E. Holding exhibited and made remarks upon a large pair of horns belonging to a species of Muntjac (*Cervulus*) received from Singapore.—Mr. W. E. de Winton exhibited and made remarks upon the tail of a Common Fox (*Canis vulpes*), showing the gland on the upper surface covered with straight coarse hair, the existence of which appeared to be little known.—Dr. Arthur Keith read a paper on the relationship of the chimpanzees to the gorilla. He referred to the ape "Johanna," which is on exhibition, under the name of a gorilla, at Messrs. Barnum and Bailey's menagerie, but which was undoubtedly a chimpanzee. "Johanna" showed all the characters of "Mafuka," an ape which, when exhibited in the Zoological Gardens at Dresden, gave rise to a prolonged discussion as to her nature. Both evidently belonged to the variety or species of chimpanzee to which Du Chaillu had given the name of "Kooloo-kamba." "Johanna" was the first chimpanzee, so far as Dr. Keith was aware, that had lived long enough in captivity to complete her dentition, which apparently finished, by the appearance of the canine teeth and last molars, about the twelfth or thirteenth year. She was the second chimpanzee in which the phenomena of menstruation had been observed. In her it occurred every twenty-third or twenty-fourth day, and lasted for three days; the discharge was profuse, and first appeared in about the ninth or tenth year. All the chimpanzees, with the characters of "Johanna," appeared to come from the West Coast of Africa, south of the equator. "Johanna" had the habits and mental temperament of the chimpanzee; her teeth, hands, nose, and ears were also characteristic of that species. Evidence was produced to show that the gorilla, in many of its characters, was the most primitive of the three great Anthropoid apes, and probably retained more of the features of the common anthropoid parent than either the chimpanzee or orang-utan. The chimpanzee was to be looked on as a Gorilline derivative in which the teeth had undergone very marked retrograde changes, accompanied by corresponding changes in the skull and muscles. The various races or species of chimpanzee described differed in the degree to which they had lost their Gorilline characters. Most of the characters which had been ascribed to these species were really only characters of individuals, or were due to age or sex. The skulls of the Central-African chimpanzee certainly showed distinctive features. It was probably a well-marked race. There was not enough material collected as yet to allow a definite statement to be made as to the distinctive features of other races. Du Chaillu was the best guide up to the present time, and the Central-African form might be added to the three species described by him. It was possible, however, that it might be found of the chimpanzees, what Selenka has shown to be true of the orang-utans, that these species were of the nature of local forms.—Mr. W. L. H. Duckworth read a note on the specific differences in the Anthropoid apes, dealing in the first place with a specimen in the Zoological Museum at Jena. The specimen in question was labelled "young female gorilla," but Mr. Duckworth had come to the conclusion that it was not a young animal, and that it was a chimpanzee and not a gorilla. In the second place, the work of Profs. Kukenthal and Ziehen on the "Cerebral Hemispheres of the Primates" was dealt with, and the failure of these authors to recognise the identity of *Gorilla engena* and *Troglodytes savagii* was commented on. Lastly, the reported occurrence of a gorilla at Stanley Falls on the Congo was mentioned, though the specimen in question seemed to be rather a chimpanzee than a gorilla.—Prof. B. C. A. Windle and Mr. F. G. Parsons presented a paper on the muscles of the head, and forelimb of the Edentata. The results were obtained by comparing the already existing scattered literature with a series of recent dissections. In some cases five or six records of the same animal were present, and thus the risk of stating individual variations as the normal arrangement was lessened. This paper was a purely technical record, all generalisations and deductions being reserved for a second part.—Mr. Martin Jacoby contributed a second part of a paper entitled "Additions to the knowledge of the Phytophagous Coleoptera of Africa." It contained descriptions of seventy-two new species of the groups *Halticinae* and *Galerucinae*, six of which had been made the types of new genera.

Mathematical Society, March 9.—Lieut.-Colonel Cunningham, R.E., Vice-President, in the chair.—Dr. Larmor, F.R.S., made some remarks on the phenomenon of Zeeman and its bearing on the problem of the origin of spectra. Dr. Hobson, F.R.S., and Mr. Hargreaves spoke on the subject of the communication.—Dr. Macaulay read a short note by Mr. G. B. Mathews, F.R.S., on involution.—Other papers communicated were: Note on the expansion of tan (sin θ) − sin (tan θ) in powers of θ, Mr. R. H. Pinkerton; note on a property of groups of prime degree, by Prof. Burnside, F.R.S.; and note on the invariant total differential equation in three variables, by Prof. J. M. Page. In the last paper it was pointed out that any number of *types* of invariant total equations can be established; and, in a large number of cases, they can be established very simply. When these equations satisfy the condition of integrability, they can be integrated by a quadrature; and when they do *not* satisfy that condition, the *general* solution of any one of them can be found by a quadrature. Moreover, if the condition of integrability is satisfied by a total differential equation, so that its integral has the form $\phi(x, y, z, c) = 0$, the envelope of these surfaces (that is, the singular solution of the total equation), if one exists, can be found by algebraic operations; and the cuspidal edge of the envelope (if one exists) can be found by algebraic operations, and one differention.

Royal Meteorological Society, March 15.—Mr. F. C. Bayard, President, in the chair.—Mr. F. J. Brodie read a paper on the prolonged deficiency of rain in 1897 and 1898. For several years past there has existed over England, and especially over the central and south-eastern parts of the country, a remarkable tendency in favour of dry weather. The dry weather dealt with in this paper consequently came at a most inopportune time, and its effects, which would in any case have been sufficiently evident, were greatly aggravated by the state of things existing so long previously. Mr. Brodie discussed the rainfall records at eighty stations distributed over the British Isles for the eighteen months, April 1897 to September 1898; these were divided into three periods of six months each. During the period April to September 1897, the rainfall was in excess of the average over practically the whole of Ireland, the greater part of Scotland, and the north-west and south-west of England and Wales; while in the north of Scotland, and the central and the whole of the eastern part of England there was a deficiency of rain, in some parts amounting to between 60 and 70 per cent. During the period October 1897 to March 1898, with the exception of the north-west of Scotland and England, the rainfall was below the average all over the British Isles, the deficiency over the midland and south-eastern parts of England being from 50 to 60 per cent. below the average. During the period April to September 1898, two of the six months were excessively dry, and in the southern parts of England at least two others had a deficiency of rainfall. Taking the period as a whole, the rainfall over the eastern, midland and southern counties amounted to less than 80 per cent. of the average, and in the south-eastern counties to less than 60 per cent., the smallest proportion of all being 51 per cent., in London. From an examination of the Greenwich rainfall records since 1841, it appears evident that for length and severity combined, the recent spell of dry weather was the most remarkable experienced there during that period.—A paper on the climate of Jersey, by the Rev. H. W. Yorke, was read by the Secretary. The situation and geological formation of the island, together with the action of the tides, have a great local effect upon the general character of the weather. The climate as a whole is bright, genial and sunny.

Manchester.

Literary and Philosophical Society, February 21.—Mr. J. Cosmo Melvill, President, in the chair.—Dr. C. H. Lees gave an account of some preliminary experiments on the effect of pressure on the thermal conductivities of rocks and other substances, which he had undertaken with the view of providing data for a recalculation of the age of the earth by Lord Kelvin's method. The experiments showed that there was a slight tendency for the thermal conductivity to increase with pressure, which would render necessary a small lowering of the earth's age given by Lord Kelvin.—On the plague in Uganda, by the Right Rev. Bishop Hanlon (Uganda). The author described the plague, which is known by the natives as "kaumpuli," as being akin to the black plague which once scourged London. It begins suddenly, there is high fever, and a swelling, usually under the armpit. Like many plagues, it has both a mild and virulent form. The first is not attended with much fever: the swelling moves about the body, and, should it get near the heart or into the throat, death may ensue. In the virulent form the swelling seems stationary, either under the armpit or in the fork of the legs, whilst the patient dies if not speedily attended to, this being the case with many sufferers before their condition has become known to a European. This form is considered very infectious: the natives shun the sick person, and will on no account bury those who die; they even remove from the neighbourhood of the hut where the patient died. The natives have a remedy for the disease, but never have it ready to hand when required; the missionaries, therefore, keep it prepared. This remedy consists of a certain insect—a common native fly—many of which are crushed and mixed with vinegar, the preparation thus made being rubbed on the swelling. So great is the terror of the natives when attacked by the disease, that the missionaries' greatest fear is lest death should happen from sheer fright. Buddu has for many years been the centre of this plague in its worst form and Bishop Hanlon disputes the statement made by Dr. Koch that the disease has travelled from other parts of Uganda to Buddu, and thence south to German territory, he being of opinion that the plague was introduced into Uganda by way of the German East African territory, which has been for many generations the chief Arab route to that part of Africa.

March 7.—Mr. J. Cosmo Melvill, President, in the chair.—A new version of Argand's proof that every algebraic equation has a root, by Prof. H. Lamb, F.R.S.—Prof. Schuster, F.R.S., exhibited some lantern slides illustrating researches made by Mr. G. Hemsalech and himself on the velocity of metallic molecules in the electric spark (see p. 350).

Dublin.

Royal Dublin Society, February 22.—Prof. G. F. FitzGerald, F.R.S., in the chair.—Prof. T. Johnson gave an account of the improvement of bog land, illustrating his remarks by an account of the work carried on by Dr. Baumann at the bog experimental station, Bernau, Bavaria, visited by him last year.—Prof. W. F. Barrett read a paper on the remarkable thermo-electric behaviour of certain alloys of nickel steel. In the course of an examination of the physical properties of numerous alloys of steel prepared by Mr. R. A. Hadfield, of the Hecla Steel Works, Sheffield, the author found the thermo-electric behaviour of some of these alloys so remarkable as to be worthy of a separate note. Two alloys of nickel and manganese steel marked 1414 A and 1414 B, which had the enormous electric resistances of 90·6 and 97·5 microhms per cubic cm. respectively (see next paper), were found to give an almost constant electro-motive force through a wide range of temperature, when coupled with iron as the second metal. In the case of 1414 B coupled with the purest commercial iron, the electro-motive force rose rapidly up to a temperature of 300° C., and then remained practically constant up to 800° C., a range of 500° C., that is, from a low black heat up to a bright red heat. Such a couple would form a new standard of electro-motive force, as it is easily made and simply requires heating in any gas flame. Coupled with platinum instead of iron these alloys give an increasing electro-motive force, from about 200° C. to a white heat, the direction of the electro-motive force changing below 200° C. The second part of the paper deals with the curve of electro-motive force on cooling; which is found to be not coincident with that on heating in the case of iron and steel coupled with platinum. At corresponding temperatures a *lower* electro-motive force is noticed in cooling than in heating, the difference being least marked with pure iron, and most with steel, the temperature ranging from 0° to 900 C. The heating and cooling thermo-electric curves thus enclose an area which represents the molecular work done on the iron and steel during the cycle. This may be connected with the phenomena of recalescence. In the case of a couple of 1414 B and platinum the cooling curve, however, shows a higher electro-motive force than the heating curve at corresponding temperatures. The author is continuing his investigations on these and other points.—A paper on the electric conductivity and magnetic permeability of an extensive series of steel alloys (Part i.), by Prof. W. F. Barrett and Mr. W. Brown, was read by Prof. Barrett. This paper gives the main results of four years' work on upwards of a hundred different alloys of steel prepared by Mr. R. A. Hadfield. For the purpose of investigation the alloys were prepared in the form of rods 106 cms. long and about 0·5 cm. diameter. The electric conductivity was determined by the potential method, and referred to Matthiessen's standard of pure copper as 100. Some of the alloys could not be obtained in a homogeneous condition; those which could be were divided into three classes: (1) those with one element added in varying proportions, of which there were eight groups containing about fifty different alloys; (2) those with two elements added, of which there were fourteen groups, also with fifty different alloys; and (3) those with three or more elements added, of which there were five groups with six different alloys. The results were plotted in curves, and show the strikingly different effect which the addition of different elements have on the conductivity of iron. The alloys of tungsten steel diminishing the conductivity *least* and those of aluminium and silicon *most*, manganese having almost as great an effect as the two latter. In all cases the conductivity rapidly falls with small additions of a foreign element up to 2 per cent. in some cases, and 7 to 10 per cent. in others, after which larger additions of the foreign element have but a small effect on the conductivity. In the case of eight different alloys the material was obtained in the form of wire and strip, and the specific resistance and temperature coefficient determined in this condition. The highest resistance was obtained with a nickel-manganese steel alloy marked 1414 B, which gave the enormous resistance of 97·52 microhms per cubic cent. and the remarkably low temperature coefficient of 0·085 per cent. per 1° C. Another similar alloy, marked 1414 A, with somewhat less nickel, had a specific resistance of 90·62 microhms per cubic cent. and a temperature coefficient of 0·1046 per cent. per 1° C.; another gave 89 microhms. These exceed rheostene, also an alloy of nickel and manganese steel, which was found by the authors in 1895 to have a specific resistance of 83·1 microhms per cubic cent. and a temperature coefficient of 0·109 per cent. per 1° C. The second part of the paper deals with the magnetic properties of these alloys. Permeability tests were made, and complete H and B curves obtained for forty-four different alloys. The results are given in the curves and tables attached to the paper. A standard curve was obtained of the purest commercial iron containing less than 0·03 per cent. of carbon. In the case of the tungsten steels, the results are extremely remarkable and of practical importance in the discovery of the best alloy for the construction of permanent magnets. The effect of nickel in the magnetic permeability is also very striking: here, as in other cases, the thermal treatment of the alloy after manufacture was a matter of much consequence. The rods were therefore all submitted to the same thermal treatment, and the permeability taken after annealing. In addition, duplicate sets of many of the alloys were made in the annealed, and unannealed condition, and the electric conductivity and magnetic permeability with complete B and H curves determined in both conditions. The annealing process consisted in heating the rods to a temperature of 1000° C. in a large annealing furnace, and then allowing them to cool very slowly down to the temperature of the air. This took nearly 100 hours, or upwards of four days and four nights.

Edinburgh.

Royal Society, February 20.—Prof Chrystal in the chair.—Dr. Buchan, in a communication on the tidal currents of the North Sea, drew attention to the facts which had been established by experiments made by the Scottish Fishery Board. According to Dr. Fulton's summary, the current of surface waters was down the east coast of Scotland and England as far as Spurnhead, then eastwards towards the north of Denmark, and finally

northwards along the Norwegian coast. Dr. Buchan pointed out that two important factors contributed to the production of this system of currents. (1) The earth's rotation causing a westward lag of water passing from higher to lower latitudes, and an eastward acceleration of water flowing from lower to higher latitudes; and (2) the westerly and south-westerly direction of the prevailing winds giving the eastward set to the water between the Wash and Denmark. Considerable discussion followed this paper, Sir John Murray expressing doubt as to the sufficiency of the evidence for the particular circulation of currents given on Dr. Fulton's map, while Dr. Knott doubted whether the observed drift of bottles in the North Sea should be ascribed to the *tidal* currents as such, and not rather to the resultant effect of wind over the Atlantic superposed upon the tidal ebb and flow.—Prof. Tait's paper on the experimental bases of Prof. Andrews' paper on the continuity of the gaseous and liquid states of matter (*Phil. Trans.*, 1869), was a communication of data hitherto unpublished, the necessity for which for certain purposes had been pointed out by Mr. Tsuruda, of Tokyo University, in a recent letter to NATURE.—Dr. C. G. Knott, in a note on magnetic twist in nickel tubes, showed how remarkably accordant were the results of experiment with the theory that the twist in a nickel tube, circularly and longitudinally magnetised, was to be explained in terms of the elongations along and perpendicular to the magnetising force. It was necessary, however, to take into account the effects of hysteresis.

Mathematical Society, March 10.—Dr. Morgan, President, in the chair.—The following papers were read:—"Note on attraction," by Prof. Tait (communicated by Dr. C. G. Knott); "On wireless telegraphy and high potential currents," by Mr. J. R. Burgess.

PARIS.

Academy of Sciences, March 13.—M. van Tieghem in the chair.—On the numbers of Betti, by M. H. Poincaré.—On the double cyanides, by M. Berthelot. Thermochemical studies on the replacement of potassium by hydrogen in cyanides by weak acids, such as boric and carbonic acids, sulphuretted hydrogen and phenol.—Does iodine exist in the air, by M. Armand Gautier. The air was carefully filtered over glass wool, and the deposit treated with water, so that iodine was looked for in three places, in those solid substances deposited on the glass soluble in cold water, substances deposited but insoluble in water, and gaseous substances carried on by the filtered air. The minute precautions necessary to guard against the accidental introduction of iodine are carefully described, and results given for air of various localities: town, country, sea and mountain. No iodine could be detected in the filtered air in any case; neither could any soluble iodides be found in the deposit on the glass. Minute traces could, however, be detected in the solid deposit after this had been fused with potash, showing that the iodine was present in the form of complex iodo-compounds, perhaps suspended spores, lichens, or algæ. Sea air contained thirteen times as much iodine as Paris air, the latter containing only ·0013 mgr. per 1000 litres.—An attempt at a new form of the relation $f(p, v, t) = 0$; the case of a state of saturation, by M. E. H. Amagat.—On the interpretation of a limited number of observations, by M. E. Vallier. The author discusses the effect upon the mean of a small number of observations of the same quantity, of rejecting one whose deviation from the mean is large.—M. R. P. Colin was elected a Correspondant for the Section of Geography and Navigation, in the place of M. Manen.—Observation of the Swift comet (1899 *a*), made with the large equatorial of the Observatory of Bordeaux, by M. F. Courty.—On two ancient Bielid showers, by M. D. Eginitis.—On the mechanism of the disintegration of hydraulic cements, by M. H. Le Chatelier. The disintegration of hydraulic cement after some months or years cannot be ascribed to the hydration of free lime or magnesia, as the latter would be a matter of days at most, but would appear to result from two causes: the greater or less solubility of the active constituents of the cement, and the variation of solubility of the solids with the pressure they support.—On the conditions of maximum sensibility of galvanometers, by M. C. Féry.—On a very sensitive coherer, obtained by the simple contact of two pieces of carbon; and on the proof of extra currents induced in the human body by electric waves, by M. Thomas Tommasina. The author has succeeded in making a detector for electric waves, or coherer, out of two electric light carbons, which possesses the property of losing its conductivity with extreme ease with a very slight shock.—Death by alternating electric currents, by MM. J. L. Prevost and F. Battelli.—On methyl-ethane-pyrocatechol, by M. Ch. Moureu. This substance has been prepared from ortho-oxyphenoxyacetone by two methods: one by the action of phosphorus pentoxide in presence of quinoline; the other by treating with acetyl chloride in presence of orthoformic ether.—Double iodates of manganese peroxide, by M. A. Berg.—Researches on αα-dimethyl-glutaric acid, by M. E. E. Blaise. Attempts to synthesise αα-dimethyl-glutaric acid having failed owing to the production of a pyrrolidine compound, this last substance was also prepared from the natural acid by conversion into the amide and treatment of this with hypobromite. The synthetical pyrrolidine derivative proved to be identical with that obtained from the natural acid, thus proving the constitution of the latter.—On the hæmatin of blood, and its varieties in different species of animals, by MM. P. Cazeneuve and P. Breteau. Pure crystallised hæmatin prepared from the blood of the cow, horse, and sheep showed distinct differences in composition, particularly in the amounts of iron and nitrogen.—On a very sensitive reaction of acetone-dicarboxylic acid, by M. G. Denigès. With acid solution of mercuric sulphate this ketonic acid forms an insoluble compound, even in very dilute solution. The time that the turbidity takes to appear after heating with the reagent is a function of the amount of ketone-acid present, and upon this fact the author bases a method of estimating citric acid.—Oxidation of secondary and tertiary amines, by M. Œchsner de Coninck.—Method of water analysis applicable to water softening on the technical scale, by MM. Léo Vignon and Meunier.—On the use of lime for preparing wool for the Aye-bath, by MM. Ch. E. Guignet and Em. David. The authors have successfully applied on the technical scale an observation of Chevreul on the favourable effect of a lime-water bath upon wool previous to dyeing.—On the reducing power of the tissues: muscle, by M. Henri Hélier.—Synthesis of some vowels, by M. Marage.—On the pathogenic agent in hydrophobia, by M. E. Puscarin.—On an oxydase secreted by the coli-bacillus capable of producing a pigment, by M. Gabriel Roux. The most suitable culture for this purpose was found to be an extract of the head of the artichoke, incorporated with gelatine in the usual proportions. This when sown with the *bacillus Coli communis* gives a copious culture, and acquires a fine emerald-green coloration. Under similar conditions the Eberth bacillus gives rise to no special tint.—On the Algæ which grow upon *Maia squinado*, in the Bay of Biscay.—On the use of colouring matters in investigating the origins of springs, and of waters filtering into these, by M. A. Trillat.

NEW SOUTH WALES.

Royal Society, December 7, 1898.—The President, G. H. Knibbs, in the chair.—The following papers were read:—"The group divisions and initiation ceremonies of the Barkunjee tribes," by R. H. Mathews.—"Native silver accompanying matte and artificial galena," by Prof. Liversidge, F.R.S. The specimens exhibited were obtained from between two courses of brickwork in the arch over the vault of an old reverberatory furnace; the upper course had been raised bodily, but remained intact, and the space between became filled to a thickness of about four inches with a layer of clean matte; the metallic silver occurs on the surfaces in the cracks and crevices of the matte and bricks.—"The blue pigment of corals," by Prof. Liversidge, F.R.S. The coral examined was *Heliopora coerulea*, obtained by Prof. David from Funafuti Atoll when conducting the Coral Reef Exploration in 1897. He states that it is very abundant there in places. The specimens were of a dull, light slate-blue colour externally and a little darker internally (see Moseley's paper in the *Challenger* Report, Zoology ii., p. 109). The pigment has not yet been obtained in a pure condition, as the quantity at disposal was very small. Neither has it yet been obtained in a crystallised condition; its best solvent appears to be glacial acetic acid, to which it imparts a rich blue colour. It appears to be quite distinct from indigo, also from the blue pigment of lobster-shell and other blue substances; the colour of the emu egg-shell seems to be somewhat similar. Its ash contains a good deal of iron, phosphoric oxide, lime, and some magnesia. Rather more than 1 per cent. of the crude pigment was obtained from a freshly collected specimen; an old water-worn dead specimen yielded only ·26 per cent. of pigment. It does not readily lend itself to dyeing either silk, wool, or cotton. On extracting it

in a percolator with glacial acetic acid or with absolute alcohol, it after a time changes to a green colour. Dilute solutions of indigo in acetic acid or of sulphindigolic acid fade much more quickly than solutions of the coral blue of equal depths of colour.

Amsterdam.

Royal Academy of Sciences, January 28.—Prof. Van de Sande Bakhuyzen in the chair.—Prof. Martin read a paper on brackish-water deposits, occurring in the interior of Borneo, especially in the basin of the Kapooas. They came to the author's knowledge chiefly from the Mělawi (a tributary of the Kapooas). In that locality they contain species of *Arca*, *Cyrena*, *Corbula*, *Melania* and *Paludomus*, not one of which is known to have been found in other localities. Among these the occurrence of the genus Paludomus, two species of which have been found, both closely allied to still living Bornean species, is of particular importance. The deposits of the Mělawi must be of more recent date than the "intertrappian beds" of India, but still they belong in all probability to the Eocene period. Brackish-water deposits also occur along the Silat (another branch of the Kapooas), containing, however, a different fauna, chiefly characterised by the presence of two species of *Vivipara*. Perhaps these Silat sediments may prove to be older than the Mělawi sediments, but they certainly are not older than the Cretaceous formation.—Prof. Van Bemmelen on the isotherms (c, p) at 15° of dehydration, rehydration and re-dehydration of the hydrogel of Fe_2O_3 (c = percentage of water, p = vapour pressure), and presented on behalf of Mr. B de Bruyn a paper on the equilibrium of systems of three substances, two of which are liquids.—Prof. Cardinaal made a communication concerning Sir R. H. Ball's theory of screws, showing the application of Caporali's method of representation to screws, belonging to a system of the fourth order. Screws in a plane, or passing through a point, were chiefly discussed.—Prof. Lorentz on the vibrations of electrified systems, placed in a magnetic field. A contribution to the theory of the Zeeman-effect.—Prof. Jan de Vries on trinodal quartics. As is well known, the six points in which a trinodal quartic is cut by the lines that touch it in the nodes, lie in a conic, and there is a second conic, containing the points of tangency of the six tangents, that may be drawn from the nodes to the quartic. The author proved that these two conics have two residual points in common. In connection with the theorems, found by Brill (*Math. Ann.*, xii. 106, and xiii. 182), according to which the six points of inflexion are on a conic, which cuts the first-mentioned conic on the quartic, the residual points therefore belong to the three remarkable conics. The author also proved that the quartic contains three systems of inscribed quadrangles, so that in the case of each system the intersections of opposite sides coincide with the intersections of two bitangents.—Prof. Van der Waals presented a paper by Mr. J. J. Van Laar, of Utrecht, entitled, "Calculations of the second correction on the magnitude b of Van der Waals's phase equation."

DIARY OF SOCIETIES.

THURSDAY, March 23.

Society of Arts, at 3.—London Water Supply: Walter Hunter.

Institution of Electrical Engineers, at 8.—The Hissing of the Electric Arc: Mrs. Ayrton. (Illustrated by Experiments.)

FRIDAY, March 24.

Royal Institution, at 9. Transparency and Opacity: Lord Rayleigh, F.R.S.

Physical Society, at 5.—On the Criterion for the Oscillatory Discharge of a Condenser: Dr. Barton and Prof. Morton.—The Minor Variations of the Clark Cell: A. P. Trotter.

SATURDAY, March 25.

Royal Institution, at 3.—The Mechanical Properties of Matter: Lord Rayleigh, F.R.S.

Essex Field Club (at Municipal Technical Institute, Stratford), at 6.30.—Annual Meeting.—Presidential Address: Life Problems in Modern Science: David Howard.—Life-History of the Tiger-Beetle (*Cicindela campestris*): Fred. Enock.

MONDAY, March 27.

Royal Geographical Society, at 8.[illegible]—Illustrations of Waves: Vaughan Cornish.

Institute of Actuaries, at 5.30.—Some Notes on Sinking Fund Assurances: J. E. Faulks.

TUESDAY, March 28.

Anthropological Institute, at 8.—Mitla (State of Oaxaca, Mexico): a Study of its Ancient Ruins and Remains: Wm. Corner. (With Lantern Illustrations, Maps, Plans, Drawings, and Antiquities).—Mr. Corner will also exhibit a Collection of Recent Photographs of North American Indians, taken by Rinehaut, Omaha, Neb., U.S.A.

Royal Horticultural Society.—Prof. Henslow's Demonstration.

Institution of Civil Engineers, at 8.—Alloys of Iron and Nickel: Robert Abbott Hadfield.

Royal Photographic Society, at 8.—Ozotype with Carbon Tissues, a New Method of Pigment Printing: T. Manly.

WEDNESDAY, March 29.

Chemical Society, at 3.—Anniversary Meeting.—Election of Officers and Council.—President's Address.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Report of the Seventh Meeting of the Australasian Association held at Sydney, 1898 (Sydney)—Botanische Untersuchungen: S. Schwendener (Berlin, Borntraeger).—In the Guiana Forest: J. Rodway, new edition (Unwin).—Astronomical Observations and Researches made at Dunsink, Part 8 (Dublin, Hodges).—Energy and Heat: J. Roger (Spon).—The Entropy Diagram and its Applications: Prof. J. Bouloin, translated by B. Donkin (Spon).—The Administrative Control of Tuberculosis: Sir R. Thorne Thorne (Baillière).—Haunts and Hobbies of an Indian Official: M. Thornhill (Murray).—Funafuti: Mrs. E. David (Murray).—Queen's College, Galway, Calendar for 1898–99 (Dublin, Ponsonby).—Karl Ernst von Baer und Seine Weltanschauung: Prof. R. Stölzle (Regensburg, National Verlagstanstalt).—Report of the U.S. National Museum, 1896 (Washington).—The Dawn of Reason: Dr. J. Weir, jun. (Macmillan).—Allgemeine Erdkunde, iii. Abteilung (Wien, Tempsky).—The Lepidoptera of the British Islands: C. G. Barrett. Vol. v. (L. Reeve).—Examination of Water: Prof. W. P. Mason (Chapman).—The Microscopy of Drinking-Water: G. C. Whipple (Chapman).—Ichthyologia Ohiensis, or Natural History of the Fishes inhabiting the River Ohio and its Tributary Streams: C. S. Rafinesque and Dr. R. E. Call (Cleveland, Burrows).—Organoterapia: E. Rebuschini (Milan, Hoepli).—On Centenarians and the Duration of the Human Race: T. E. Young (Layton).—Sitzungsberichte der K. V. Gesellschaft der Wissenschaften. Math. Naturw. Classe, 1898 (Prag).

Pamphlets.—Address delivered by James Stuart, M.P., on the Occasion of his Installation as Lord Rector of the University of St. Andrews, January 23, 1899 (Macmillan).—The Chinch Bug (Washington).—The Water Supply of Sussex from Underground Sources: W. Whitaker and C. Reid (London).—Royal Geographical Society Year-Book and Record, 1899 (1 Savile Row).—Report of the Meteorological Council for the Year ending March 31, 1898, to the President and Council of the Royal Society (London).

Serials.—American Journal of Science, March (New Haven).—Himmel und Erde, March (Berlin).—Bibliography of the more Important Contributions to American Economic Entomology (Washington).—Journal of the Institution of Electrical Engineers, March (Spon).—Proceedings of the Royal Society of Edinburgh, Vol. xxii. pp. 249–360 (Edinburgh).—American Naturalist, March (Ginn).—Popular Astronomy, March (Northfield, Minn.).—Zoologist, March (West).

CONTENTS.

THURSDAY, MARCH 30, 1899.

METEOROLOGY IN FRANCE.

Traité élémentaire de Météorologie. Par Alfred Angot, Météorologeste titulaire au bureau central météorologique. Pp. vi + 412. (Paris: Gauthier-Villars, 1899.)

IN the opinion of the author, meteorology, or more generally the physics of the earth, does not receive in France that study and attention which the subject deserves, both from its inherent interest and its possible usefulness. He traces this indifference to the absence of regular teaching in the schools devoted to higher education, to the want of an enlarged professoriate, and, though the statement is not made directly in words, to a deficiency of text-books written with the special object of instruction. He contrasts the devotion that is paid to the study of meteorology in the United States with the apparent carelessness that he perceives in his own country, and offers this book, which is the *résumé* of a course of lectures he has given in his professorial capacity, to attract more general attention to the subject, and to fill a gap in the scientific literature which his experience teaches him exists. Without the same means of judging of its necessity as M. Angot possesses, we cannot say how far this hope will be realised, but one can have no hesitation in saying that he has offered to his countrymen an admirable treatise, well calculated to serve the ends he has in view. It is well arranged, clearly written, not overloaded with details, either numerical or instrumental, presenting all the facts that are fairly well established, and indicating as far as necessary the lines of future investigation.

M. Angot divides his treatise into five books, each of which is fairly complete in itself. These books are entitled "Temperature," "Atmospheric pressure," "Aqueous vapour," "Disturbances of the atmosphere," and "Weather forecasts." In other words, we have the results of observation followed by theoretical deduction and practical application. The general plan followed in each of the three first books is to discuss the results of observation as derived directly from instruments. These observations disclose the variations that are noticeable throughout the day and throughout the year, each of which comes under examination in turn. The explanation of the several variations follows, both as to amount and time of displacement; that is to say, both amplitude and phase. This explanation is traced to the general effect of the sun as modified by the action of local circumstances. The plan is very generally adhered to throughout and is satisfactory. It brings clearly before the reader the amount of disturbance that is to be explained, and the efficiency of the causes to explain the results of observation. Of course diagrams and graphical illustration are frequently used, and where it has been necessary to exaggerate effects in order to make them easily and saliently visible, the scale on which the enlargement has been made is stated. It would be well if this practice were more frequently followed in elementary works; very erroneous notions are sometimes carried away by students, who remember the diagrams more perfectly than the letter-press they are intended to illustrate.

In the determination of temperature, which is the first climatic element considered, the observations, whether of the atmosphere, the soil, or of rivers, are readily made, and the explanation easily traced on general principles. The author writes for those who have only elementary notions of physics and mathematics, so that he sometimes states a law and gives its experimental proof without entering into a complete mathematical demonstration. This is noticeable in the matter of underground temperatures, an interesting subject treated here more fully than in most elementary works, but there is no specia reference to the theory of conductivity of heat. In this course the author is amply justified. In treating of the physics of the earth's crust, it is permissible to assume the results of laboratory and theoretical inquiries into the subject of heat and its diffusion.

The division entitled atmospheric pressure necessarily includes some general notion of air movements, of barometric gradients and of cyclonic disturbances, though the more interesting results arising from the discussion of the behaviour of the atmosphere over areas of high and low pressure are reserved for the penultimate section on the perturbations of the atmosphere. We have in the discussion of the vexed question of diurnal variation of pressure, an instance of the manner in which the author treats subjects that are still more or less uncertain and require further examination. M. Angot prefers to leave the many unsatisfactory hypotheses that have been suggested to explain the cause of this phenomenon severely alone. He is content to say that a complete explanation is still wanting. In his discussion of the observed fact, he follows the explanation originally due to Carlini, and developed by Lamont, of the superposition of two distinct oscillations—the diurnal and the semi-diurnal wave. The latter he leaves where he found it. Into the former, as due to diurnal variation in temperature, the author enters very thoroughly, tracing the modifications which are produced by latitude and elevation above the earth's surface. He quotes the observations obtained from barometric readings on the Santis and on Mont Blanc, but makes no reference to Prof. Pickering's measures carried out at elevated stations on the Andes.

The section on aqueous vapour and of the various forms it subsequently assumes, will be found very interesting, embracing all the facts which have been clearly established. We think a little more consideration might have been given to the subject of the action of dust in the atmosphere, both in connection with precipitation and, subsequently, when treating of the optical phenomena of the atmosphere. We should gather that M. Angot is doubtful of the value of much of Mr. Aitken's work, for example. In the sub-section on clouds, some very good illustrations are given. The importance of accurate observation is here and elsewhere insisted on, and we think necessarily; for notwithstanding recent efforts to inculcate a better knowledge of cloud forms and motions, it will generally be admitted that, except among cloud specialists, uniformity of description and exactness of nomenclature are still wanting. The publication of the "International Cloud Atlas," a work on which consider-

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able attention and ability have been expended, and from which a noticeable advance was anticipated, has, so far as one can observe in this country, remained a dead letter. It may be that the Meteorological Office has sent out instructions to the numerous army of observers who contribute to the mass of records accumulated at the office, but so far they do not seem to have been followed with a practical result. On this ground we welcome the effort that any less official source may make to instruct a public who cannot but be benefited by more accurate and scientific observation.

Perhaps the most interesting portion of the book will be found in the last two divisions, wherein we meet with the deductions and conclusions drawn from observation rather than the mere statement of facts. In the eyes of many, the forecasting of weather, including as it does the possibility of safe-guarding against the action of severe storms, whether inland or on our coasts, is regarded as the final outcome of meteorological observation. No office dares to issue forecasts for any particular place. Local circumstances exercise an influence which cannot be adequately taken into account. M. Angot tells us that it has not yet been found possible to divide France into more than eight divisions, and to attempt to give the probable variations in temperature and weather that will generally prevail in each district. Evidently the mechanism employed and the success that attends its use are both about the same as in England. Ninety per cent. of the forecasts are found to possess a satisfactory degree of accuracy. But it is a question whether forecasting, carrying with it an idea of prophecy, is quite the right term. Long ago Le Verrier wrote :

"The ultimate result of the organisation which we are establishing should be to announce a storm as soon as it appears at any point in Europe, to follow it on its course by means of the telegraph, and to give timely notice of it to the coasts which it may reach."

We believe that this view indicates the present position of the various meteorological bureaux. A clear evidence of the approach of a storm or of a change of weather must exist before any announcement can be made. Then it becomes a question of telegraphic communication outrunning the speed of the storm. There is no prophecy from first to last. The preparation of synoptic charts permits and assists the recognition of these signs of changes to be made earlier than would be the case, but experience seems to be often the only guide that will give the direction in which the storm will move. M. Angot regrets the position of Western Europe and the unfavourable conditions under which it is placed for gaining information from stations on the West. Telegraphic communication with Iceland would, he thinks, furnish much valuable information ; but the provision of a telegraphic cable with that remote island cannot be looked upon as likely to be made. On the possibility of predicting weather for longer periods than twenty-four hours M. Angot speaks hopefully, and seems to approve of the suggestion of Dr. Van Bebber, though we have not seen any direct reference to this meteorologist. There is no necessity to enter into this question here, since we have recently given some account of the long-continuing types of weather and the use that is made of them (NATURE, vol. lviii. p. 28). We feel that in these few remarks very scant justice has been done to a very excellent book, on the appearance of which we congratulate the author, and venture to express the hope that his intention of awakening greater interest in the subject of meteorology in France will be realised.

RIVER DEVELOPMENT.

River Development as illustrated by the Rivers of North America. By Prof. I. C. Russell. Pp. xv + 327. (London : J. Murray. New York : G. P. Putnam's Sons, 1898.)

THIS book is one of a Progressive Science Series now being published in the United States and here. The American edition was issued under the title of "The Rivers of North America." The object of the book, as set out in the introduction, is to assist the reader "in questioning the streams and in understanding their answers, and at the same time creating a desire for more light on other and related chapters of the earth's history," and in satisfying an insatiable desire which the reader is told "exists for more knowledge concerning the work of the streams to which so many of the changes that have been made on the earth's surface are due."

The book consists of nine chapters, dealing with the disintegration and decay of rocks ; the laws governing the streams ; the influence of inequalities in the hardness of rocks ; on river-side scenery ; material carried by streams in suspension and in solution ; stream deposits ; stream terraces ; stream development ; some of the characteristics of American rivers ; the life-history of a river. Of these nine chapters only one is given to the description of the rivers of America, and, with the exception of short allusions to other rivers, this only includes a very brief account of the Mississippi, the Colorado, the Columbia and the Saint Lawrence.

The book may be read with interest by readers who wish to obtain general information as to the formation and physical condition of rivers. The material is, however, not of that definite character which a reader might expect to find in a book written for a scientific series. It does not contain any information that would not be already in the possession of a student who has paid attention to the physics of rivers. The author does not appear to have made a special study of the physics of rivers, or to have carried out any independent observations or experimental research. The facts and data given have been collected from the writings of physical geographists and the reports of the United States Geological Survey. In fact the author only claims to be "a guide who points out the routes others have traversed."

In the description of the agencies which operate in the formation of water-courses, of the effects produced by running streams, and the characteristics of different rivers, the author has not confined himself to that severe simplicity of style that is generally adopted in a scientific treatise, nor has he been economical of words. In fact, those generally in use not being sufficient, he has considered it necessary to add to them. Thus the reader is told that

"When a stream has lowered its channel nearly to base-level downward *corrasion* is retarded, but lateral *corrasion* continues. Low-grade streams are the ones

most inclined to meander, and to broaden their valleys. If this process is continued for a sufficient time in any region, it will lead to the removal of all land within reach of the stream down to their own level. Base-level of *corrasion* thus becomes practically the base-level of erosion. The ultimate result of erosion is to reduce a land area to a plain at sea-level. Such perfect plains, however, are exceedingly rare; but approximations to the ultimate result are common, and plains in this penultimate stage have been named *peneplains*." . . . "The action of a stream in *corrading* its channel in one portion of its course, and *aggrading* it in another portion, is carried on at the same time and is a highly complex process."

And again,

"What charming pictures of placid rivers flowing between wooded and flower-bedecked banks, softened and partially obscured, perhaps, by moaning mists, enrich the memories of those who have travelled in the Carolinas, Georgia and Alabama! Whence the fascination of these sleepy streams, flowing through flat-bottomed valleys bordered by wildly roughened, plateau-like uplands? What has subdued the broader features of the landscape in a region where every river bank reveals folded and contorted rocks similar to those in the neighbouring mountains?"

After describing the development of rivers from observed facts, the author in the last chapter gives his imagination full play, and "pictures in his mind the leading events in the life of a majestic river whose murmurs we may be pardoned for fancying make audible the memoir of a million years." "Looking across the shimmering sea of fancy, we see the new-born consequent streams appearing like shining threads of silver when the skies are clear," &c. Instead of this imaginative description a reader interested in the history of rivers would naturally regret that the space thus occupied had not been devoted to dealing more fully with the characteristics of the few rivers of which a description is given. Thus in describing that remarkable river the Colorado, and stating that there is nothing of the same class in the whole world, and telling how that it has carved its course through solid rock, and flows in a canyon from 4000 to 6000 feet deep, with a valley more than fifteen miles across, no explanation is given, or suggestion made, as to what special characteristic the water of this river—which, as its sources flow through an arid plain, must be limited in quantity—possesses that has enabled it to perform this incredible amount of wearing away by the action of water alone. The author states that the remnants of the great plateau, across which the Colorado flowed in its infancy, was once 4000 feet lower than now; at which level it remained for tens of thousands of years while the river cut down its channel to base-level, and by lateral *corrasion* broadened its valley; during which time the climate was arid, and being subsequently slowly elevated the river once again had to begin the task of *corrading* its bed to base-level. Although the theory of the author as to the depression of the bed of this river being due to the wearing of water and not to any opening of the ground caused by earthquakes or alterations in the surface-level caused by uprisings, is that generally accepted by geologists, yet in a scientific treatise on rivers it would have been more satisfactory if some cause had been assigned why the water of this particular river should have produced such remarkable results as compared with those effected by the Niagara, the St. Lawrence, the Mississippi, or other great rivers having larger volumes of water and of equal age. In the case of the Niagara the flowing water has made such slight impression on the limestone rocks over which it flows, that little more than a surface skin has been eroded, and the striated marks due to glacial action may still be traced almost to the water's edge; and the wearing action of its flowing water has only cut back the rock over which it falls to a distance of seven miles with a fall of little over 300 feet, as compared with the 300 miles in length and over a mile in depth of the Colorado.

Although the river systems of America are of a magnificent and comprehensive character, this book would have been more instructive as a scientific treatise on river development if the author had taken a wider survey of river action, and given some information as to the characteristics and development of some of the other large river systems of the rest of the world.

PYRAMID AND PLANISPHERE.

The Book of the Master; or, the Egyptian Doctrine of the Light born of the Virgin Mother. By W. Marsham Adams. Pp. xxii + 204. (London: John Murray, 1898.)

IN a book published some three years ago Mr. Adams proclaimed what he considered to be "a clue to the creed of early Egypt." He is doubtless an enthusiast, and of the importance of his work he does not entertain the smallest misgiving. So startling, indeed, to him was the originality of his idea that he was convinced of its truth from this fact alone; to have invented it, he wrote

"were an intellectual masterpiece which surely demands nothing less than a creative genius of the very loftiest order. So majestic is the outline of the conception as it rises solemnly on the view that I cannot for a moment believe it to be the offspring of my own imagination."

Mr. Adams therefore, according to his own account, was in the enviable position of being either "a creative genius of the very loftiest order," or the discoverer of a fact that "with overwhelming splendour" illuminates "mystery after mystery of the invisible world."

The discovery which Mr. Adams heralded in this very enthusiastic manner was a mystical connection between the Egyptian "Book of the Dead" and the Great Pyramid at Gîzeh. About both these wonders of ancient Egypt many wild theories have in their time been aired, but perhaps one of the wildest is that which Mr. Adams proclaimed. For three years he published nothing further on the subject, but he has now produced another book in which he repeats and elaborates his ideas. In fact "The Book of the Master" incorporates whole passages from his former work with the change of a word or two here and there, for, as Mr. Adams rathe characteristically remarks in his preface,

"I have not thought it advisable to rewrite that which I saw no probability of improving by revision."

Mr. Adams is not content with the common-sense view of regarding the pyramids as the tombs of Egyptian kings. He suggests a "spiritual and most far-sighted

purpose" for their construction, seeing in them a mysterious type or symbol of the religious beliefs and aspirations of their builders, and he sets to work to prove his theory by tracing a correspondence between their internal arrangements and the various chapters of the Book of the Dead. With regard to his theory it will suffice to point out the fact that Mr. Adams employs the Turin Papyrus of the "Book of the Dead," which dates from a period not earlier than the twenty-sixth dynasty, to explain the arrangements of a structure erected at least 3000 years earlier. This connection between the Great Pyramid and the Turin Papyrus is not the only "revelation" Mr. Adams has given us, for he is convinced that the Deluge was merely a phenomenal inundation of the Nile valley, that Eden was situated in Central Africa, and Paradise itself in the eastern basin of the Congo. He holds views of his own, also, in comparative philology, in accordance with which he derives the response "Amen" of the Book of Common Prayer, not from the Hebrew *âmên*, "verily," but from the name of the Egyptian god Âmen-Rā. So, too, the British cheer, "Hip, hip, hurrah!" is, according to Mr. Adams, merely hieroglyphic for "On, on, to plunder!"

The form of problem, however, which appears to have most attraction for Mr. Adams is to take a building and some object with which it is apparently unconnected, and to trace wonderful and mystical connections between the two. As he formerly connected up the Great Pyramid and the Turin Papyrus, so now in his new book he traces connections between the temple of Hathor and the famous planisphere at Denderah. "To effect a comparison between the chambers of the building and the different parts of the planisphere," he writes, "and through them with the constellations of the heavens, is not a difficult task." And for Mr. Adams it certainly is not, for he proceeds to do it with the greatest ease and fluency. In fact we are convinced that Mr. Adams would find little difficulty in tracing any number of mystical relations between, let us say, the "Ingoldsby Legends" and St. Paul's Cathedral. We make a present of this suggestion to Mr. Adams, and hope that he may find time to develop it, even though he should be compelled to cease for a time from his revelations of Egyptian mysteries.

OUR BOOK SHELF.

A Laboratory Manual in Astronomy. By Mary E. Byrd, A.B. Pp. 273 + ix. (Boston: Ginn and Co., 1899.)

Owing to uncertainty of weather and the variety of times required for observations, the teaching of practical astronomy presents peculiar difficulties, and we therefore welcome a book which gives us the benefit of a teacher's extended experience. The course includes both indoor and outdoor studies, but excludes the use of instruments with the exception of a small telescope and other simple pieces of home-made apparatus.

The first four chapters consist chiefly of indoor exercises on the use of almanacs, maps and globes, and the solution of problems relating to time. These prepare the way for the outdoor observations, with which the remainder of the book is chiefly concerned. Each of the later chapters commences with a series of questions to be answered either by direct observation or from the data obtained by observation, and following these are explanations elucidating the more important points, as well as numerous examples giving results actually obtained by the students of Smith College Observatory. As examples of the class of observations to be made, we may mention meridian altitudes, and amplitudes at rising or setting, of sun, moon, and stars, the determination of time, longitude, and latitude, the identification of planets, and the observation of variable stars. Simple computations, furnishing checks on the observations, are introduced whenever possible, and throughout the whole course the student learns to enter his results methodically. One cannot help but marvel at the accuracy frequently obtained by the rough means employed.

Generally speaking, the explanatory matter is clear and complete, but we may note that no instructions are given as to placing the sun's equator in Fig. 34, and that some of the problems in Chapter iv. would be more intelligible to readers on this side of the Atlantic if a description of the apparatus called the "heliotellus" were included. For the benefit of those who live in an unfavourable climate, the use of artificial stars, as in the course at South Kensington, might be introduced with advantage. These are easily adapted to the transit instrument, wire micrometer, &c., and are always available. A useful piece of additional apparatus also would be a model sextant, such as that described in "Demonstrations and Practical Work in Astronomical Physics at the Royal College of Science, London."

The book has many novel features, and will be very helpful to teachers and students alike; while it will not relieve either from the trouble of adapting exercises to the occasion, it will greatly facilitate the preparation of working programmes.

Two classes of students may especially profit by following the course of instruction laid down, namely, those who study spherical astronomy as a branch of applied mathematics, and star-gazers who make their observations with little or no regard for mathematical considerations.

The Tutorial Algebra. Part ii. Advanced Course. ("The University Tutorial Series.") By William Briggs and G. H. Bryan, F.R.S. Pp. viii + 596. (London: W. B. Clive, 1898.)

In these 596 pages we have a treatise based on the "Algebra" of Prof. Radhakrishnan. The reason for this is that the latter book is known to be the result of a careful study of the best English authorities; while, as we read in the preface, "recent writers have shirked the task of educing what is intelligible to the average student from the work of the greatest masters of the subject. . . ." The authors have, nevertheless, taken great pains to present the student with an excellent advanced course, a more elementary course in a separate volume being promised at an early date.

It is natural that certain modifications and additions to the treatise mentioned above should find a place in the volume intended for English readers, and those included here, are, among others, logarithms, interest, convergency and limiting values.

Chapter xxvi., on the graphic representation of functions, by Mr. J. H. Grace, gives the reader a good insight into the method of discussing equations graphically; and this should serve as a useful introduction to other branches of mathematics, such as conic sections.

Throughout the book the exposition is clear, and numerous examples are inserted in the text. As a school treatise it should serve its purpose well, and those who are reading the subject by themselves will need little, if any, outside aid.

An Elementary Text-book of Botany. By Sydney H. Vines, M.A., D.Sc., F.R.S. With 397 illustrations. Pp. 611. (London: Swan Sonnenschein and Co., Ltd., 1898.)

PROF. VINES'S "Students' Text-book of Botany," or at least the first half of it, was reviewed in NATURE for October 25, 1894. This book is now widely known, and, as a well-ordered repertory of facts for the advanced student, is probably unrivalled.

The present work, as we are told in the preface, was "undertaken to meet a demand which appeared to exist for a less bulky and expensive volume." While the reduction in cost is considerable, the diminution in bulk is not so very great; the number of pages is about 600, as compared with about 800 in the larger work. The new text-book has also been somewhat simplified, by the omission of "certain difficult and still debatable topics, such as, for instance, the details of nuclear division, or the alternation of generations in the Thallophyta."

The book, however, subject to these omissions and abridgments, is the same, and for the most part verbally the same, as the original work. It is obvious that an elementary text-book, in the sense of a first introduction to the science, cannot be prepared on this principle. Such an introduction requires to be thought out as a whole, from the point of view of the beginner's needs. Prof. Vines's new publication is only to be called elementary relatively to its predecessor. It remains essentially what it was before its abridgment—a book for consultation and reference on the part of those who have already gained some considerable knowledge of the subject. For this purpose we have no doubt that the book, in its new form, will prove of great value to readers who require sound information on all parts of the science, but who do not need quite so much detail as the larger text-book contains.

It should be added that the present work has been brought "up to date," and takes account of the chief advances in the science which have been made since the publication of the "Students' Text-book."

The Principles of Agriculture: a Text-book for Schools and Rural Societies. Edited by L. H. Bailey. Pp. xv + 300. (New York: the Macmillan Company. London: Macmillan and Co., Ltd., 1898.)

THIS is a work written by eight of the professors and teachers of Cornell University. It attempts within the limits of a small volume to give an elementary popular account of the principles of agriculture. The task is made the more difficult as the subject is not limited to the discussion of the conditions necessary for the growth of field crops, but includes fruit culture, and a long section on animal physiology and nutrition. It follows, consequently, that a great deal is left out that we should have expected to find. An attempt is made to reduce the necessary deficiencies of the book by frequently referring the reader to other books treating the subject more fully.

In the earlier part of the volume there is much excellent teaching in vigorous language as to the primary necessity of a good physical condition of the soil. "The farmer should give attention to the texture of his soil before he worries about its richness. The conditions must first be made fit or comfortable for the growing of plants; then the stimulus of special or high feeding may be applied." . . . "By superior tillage you can expand one acre into eight, or by neglectful management eight acres can be reduced to one." . . . "Success in modern agriculture depends more on the size of the farmer than on the size of the farm."

The book includes not a few misstatements, the result, probably, of hasty writing for uncritical readers.

R. W.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Experiment to Illustrate the Zeeman Effect.

AN interesting dynamical illustration of the Zeeman effect may be made by fixing a gyroscope so that its axis of rotation is the line of suspension of a pendulum bar so suspended as to be capable of vibrating in any plane. When the gyroscope is rotating the plane of vibration of the pendulum rotates with a precessional motion, and when the pendulum is caused to vibrate in a circular path its rate of description of its orbit depends on its direction of rotation round its orbit. The analogy to the Zeeman effect would make the rotation of the gyroscope correspond to the imposed magnetic force and the motion of the pendulum to that of the electrons. The explanation of the motion by the properties of a gyroscope is pretty obvious. It may be a matter for further consideration whether there are analogies between the length of the pendulum and its precession when describing elliptic orbits and the Zeeman effects: the ordinary elliptic precession corresponding to such a phenomenon as the double sodium line.

GEO. FRAS. FITZGERALD.

Trinity College, Dublin, March 24.

The Colour of Sea Water.

AS Mr. Threlfall, in his letter to NATURE of March 16, seems to have fallen into an error regarding the explanation of the colour of sea water, given by me in the paper referred to in his letter, perhaps I may be allowed to make a few remarks on the subject. He says my explanation is based on the principle that sea water is a blue liquid, and that the green tint often seen in sea water is due to the presence of yellow particles. Now, while it is pointed out in the paper referred to that yellow particles will make a blue water appear greenish, yet it is nowhere stated that yellow particles are the exclusive cause of greenness in sea waters. What may have caused Mr. Threlfall to make this overlook, may be the fact that only an abstract of the paper was published, and the different points, therefore, not fully explained. Still, I think there is enough in the abstract to show that greenness in sea water was recognised to be due in some cases to other causes than the one referred to in Mr. Threlfall's letter.

At the beginning of the paper referred to, experiments are described showing that the water of the Mediterranean is a blue transparent medium full of solid floating particles, and that it is "these solid particles that determine the brilliancy, and the selective absorption of the water determines its colour." It is then shown that the colour of the particles will have an influence on the appearance of the water; that if the particles be yellow the blue water will appear green, as any one can observe on looking at the Mediterranean water where it overlies a yellow sand bed. After describing experiments made on the waters in the Italian and Swiss lakes, the paper goes on to the consideration of the experiments made on sea water on the west coast of Scotland, from which I quote the following:—"The water was here found to be much greener than any previously examined. A large quantity of the water was filtered, when it was found that most of the suspended particles were fine grains of sand. From this it is concluded that the greenness of our northern seas is *in part* due to the reflecting particles being yellow, and the reflected light, therefore, deficient in the more refrangible rays. These yellow sand particles not only explain *part of* the greenness of our northern seas, but they also explain their comparative darkness and deadness, the yellow sand particles reflecting so little light. The importance, however, of even these bad reflectors was very evident during the time the observations were being made. It was noticed that the water was much more brilliantly green during and immediately after an inshore wind, and when the filter showed the water to have a good deal of sand in suspension, than after a calm, when many of the particles had settled out. *Some water collected about a mile seaward from Ballantrae was examined in a glass tube* 7½ *in. long, and was found to be of a blue-green colour.*"

If attention be given to the parts printed above in italics, I think it will be admitted that the writer did not consider the yellowness of the reflecting particles as the exclusive cause of the greenness in sea water, and in the last sentence quoted it is stated that the water on the west coast of Scotland, when examined in a long tube, transmitted a blue-green light, therefore greener than the water of the Mediterranean.

The paper concludes with some tests made in Loch Lomond and with pure water, and a number of well waters; these were found to vary from blue to yellowish brown. As the waters of most of our rivers and lakes are yellowish brown, it is probable that it is the addition of this yellowish water to sea water that makes the seas surrounding our islands of a greenish colour.

John Aitken.

Ardenlea, Falkirk, March 20.

The Wehnelt Current Interrupter.

The form of contact breaker recently introduced by Wehnelt is attracting so much notice, that it may be worth while to draw attention to an essentially identical arrangement described by Spottiswoode for use with an induction coil, more than twenty years ago (*Proc. Roy. Soc.*, vol. xxv. p. 549). He says: "Another form of contact breaker was also occasionally used. The principle upon which it was based was the sudden disruption of a thin film of conducting liquid by a discharge between the electrodes of a circuit. The mode of effecting this was to make one electrode terminate in a platinum plate fixed in a horizontal position, and supplied with a uniform film of dilute sulphuric acid; the other in a platinum point, the distance of which from the plate is capable of delicate adjustment by means of a screw. Electro-motive force required for this break is not less than that of five cells of Grove. As soon as the current passes, the fluid between the plate and point will be decomposed, and electrical continuity broken. This done, the fluid flows back again, and continuity is restored. By a proper adjustment of the supply of fluid and of the distance between the electrodes (the latter varying from ·05 to ·001 of an inch), the number of disruptions may be made to attain 1000 per second. The currents delivered by this form of break are exceedingly uniform, and the effects produced are quite equal in delicacy to those produced by the electro-magnetic or by the wheel break."

R. J. Strutt.

In reference to the Wehnelt current interrupter—in 1874 I used a similar interrupter on a coil with fifty Groves' cells. The idea was not even then new, for although my experiment was due to accidental short-circuiting of electrodes during electrolytic experiments, which led to my final application of the so-called interrupter as a resistance to current, and then as a rapid make-and-break, I found that some of the old masters of electrics had evidently used it before. Since November 1896, I have always endeavoured in using a Jackson tube to condition the tube by heating, when connected with coil, so that the make-and-break of coil shows infinitesimal sparking and works with such rapid vibrations that a musical note is produced, the pitch varying as the position of the flame heating the tube is altered. Shadowgraphs can then be obtained of the human trunk from thirty-five seconds upwards, and the results on English fluorescent screens are almost perfect. This has all been mentioned in my lectures at the Royal Artillery Institute, &c., the first being at the end of October 1896.

William Webster.

The Laboratory, Art Club, Blackheath.

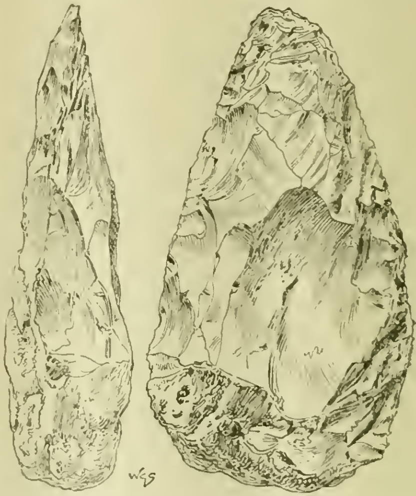
Palæolithic Implements from the Valley of the Ver.

The river Ver rises at Markyate Street, near Dunstable, at the junction of Hertfordshire with Bedfordshire, and runs to St. Albans, whose ancient name Verulamium is derived from the river. Leaving St. Albans, the river becomes the Colne and joins the Thames at Staines. Many Palæolithic implements have been found by myself and others in the valley of the Colne, but up to now none have been recorded from the valley of the Ver.

It is true that for many years I have found Palæolithic implements in contorted drift (or where contorted drift has been) on the highest hill-tops north of the source of the Ver, but none of these positions have been in the river's valley. They have belonged to large ponds and swamps of Palæolithic age on the hill-tops.

For the last three or four years small excavations for clay have been made in a brick-yard east of Markyate Cell, but until this last winter I have never seen any human work amongst the excavated material. The implements occur in relaid contorted drift, which has been washed in patches from higher ground. The implementiferous material only occurs here and there in the brick-field; it is a brown clay full of large stones, and rests upon a brick-earth of much greater age, probably glacial, which in turn rests on Lower Chalk. The implementiferous clay is on the surface, and is never more than two feet deep. The pit is 108 feet above the Ver, and 547 feet above the Ordnance datum. On the hills to the north, and removed from the water-shed of the Ver, implements occur at 595 feet.

I have lately found six Palæolithic implements in the valley of the Ver at Markyate Street, all above the average in size and weight; they are faintly ochreous and slightly abraded. The example illustrated to one-half the actual size—1673 in my



Palæolithic implement from the valley of the Ver. One-half actual size

collection—weighs 1 lb. $6\frac{3}{4}$ ozs., two others weigh 1 lb. 1 oz. each, others 1 lb. 4 ozs. and 1 lb. $4\frac{1}{4}$ ozs. With these implements were numerous large cores and large blocks of flint, from which a flake or two had been struck. These were abandoned by me as too heavy for convenient carriage. Only one flake has come to hand; in fact, no stones as small as ordinary flakes are in the material. I have found a few Palæolithic flakes one and a half miles nearer St. Albans, in the same river valley, north of Friar's Wash.

Twenty-one years have now passed since I first directed attention to the Palæolithic implements found on the hill-tops of North Herts (*Jour. Anth. Institute*, vol. viii., 1878). Since that time I have greatly extended my observations on these hills, but no evidence whatever has been seen by me indicative of a greater antiquity than post-glacial. The high-level implements at North Herts and South Beds are never in glacial material. The implementiferous brick-earth is always on the top of the glacial clay, where the latter is present, and to this rule I have seen no exception. The glacial gravels and clays and the boulder clay are here positively barren of human work.

Dunstable.

Worthington G. Smith.

THE NATIVE TRIBES OF CENTRAL AUSTRALIA.[1]

THE sincere efforts of some of the Australian governments to protect the native tribes have met with eminently satisfactory ethnographical results. It is only a few months ago that a highly meritorious work on the Queensland natives by Walter E. Roth was published by the Queensland Government, and we have now before us a very thorough work dealing with the native tribes of Central Australia—the joint production of a professor of biology and a protector of aborigines. These gentlemen have spent many years in the study of their black friends, and have become initiated into those mysteries into which Grey, Gason, Fison and Howitt were the first to make headway. The book thus contains a considerable amount of information quite new to us, as well as other matter largely confirmatory of the investigations of their predecessors, rendered all the more valuable by the conscientious pains that have been taken to thoroughly investigate everything in connection with native customs with which they have had to deal. In referring to the common statement that the Australian native is incapable of gratitude, the authors explain the position taken up by the aboriginal as regards this virtue, and point out that, although he is exceedingly liberal himself, he does not think it necessary to express his gratitude when he receives a gift from one of his own tribe, and that we should, in order to understand the sentiments of the native, put ourselves into his mental attitude, and then the question is capable of being more or less explained or understood. It is no doubt by their adoption of this attitude that they have been peculiarly successful in their studies. With the advent of the white man the secret ceremonies fall into disuse, for the young men get attracted away to the stations, and naturally feel less disposed to obey their elders; and these, in turn, consider the growing youth unworthy of initiation; hence the ceremonies get neglected and die out. It is of consequence therefore that every scrap of information regarding them be properly recorded, and in doing this Messrs. Spencer and Gillen have collected a mass of detail which, while it may at first sight appear somewhat superfluous, will be invaluable for future reference as further investigations are carried on.

Valuable portions of the book consist in the comparisons made between the results of studies on the Australian tribes under review, and those of studies made by anthropological students elsewhere, and it is significant of the importance of field work that the theories of McLennan and Westermarck on group marriage are not borne out by the present investigations. For instance, marriage by capture, notwithstanding what has been written on the subject, is an exception rather than the rule with the Australians, so that a good deal that Westermarck bases on this custom falls to the ground. In group marriage the authors distinguish (p. 108) three grades of development, and from their studies of these conclude that the customs indicate a temporary recognition of certain general rights which existed in times previous to that of the clearly defined system of group marriage. The authors are careful to add that the indications do not afford any direct evidence of the former existence of actual promiscuity, but only that evidence is afforded in such direction. The tendency of the evidence of prehistoric promiscuity is, however, so strong that we cannot doubt its former existence; and if the authors had elucidated no other point than this, they would have done good work. The totemism of the tribes shows some curious departures from the customs commonly associated with the idea of totemism as met with amongst other Australian tribes, as well as with primitive people elsewhere. Each individual considers himself the direct reincarnation of an ancestor, whose spirit having become humanised, has entered a woman, and so the individual is born in human form; the totemic animal or plant is not regarded exactly as a close relative, and an individual may help to kill or destroy his totem; members of the same totem are not bound to assist one another, nor does totemism rule in marriage, so that two individuals of the same totem may be lawfully man and wife. The authors are unable to explain satisfactorily these anomalies, nevertheless their inquiries on the subject of totemism are quite amongst the most fascinating of the book. The Arunta tribe, the description of whose customs occupy the greater portion of the monograph, reckon descent through the male instead of, as do most of the surrounding tribes, through the female; but, as is pointed out (p. 36), it is doubtful whether in all cases the counting of descent in the female

FIG. 1.—Iruntarinia ceremony of the Unjiamba Totem to illustrate one form of Nurtunja; the small cross pieces represent pointing sticks.

[1] "The Native Tribes of Central Australia." By Prof. B. Spencer and F. G. Gillen. Pp. xx + 671. (London: Macmillan and Co., Ltd., 1899.)

line has preceded the counting of it in the male line, and we are also shown good reason for excepting the statement that descent in the female line is necessarily a sign of primitiveness. Perhaps the divergences in the customs recorded of some of these Central Australian tribes may have a connection with the traditional wanderings of their Achilpa ancestors, concerning which we are provided with detailed accounts and maps of the routes followed. The fact, that the ancestors came from the south-west and south-east, and found themselves among already located peoples, looks as if the northern immigration having crossed Australia and reached the extreme confines of the continent had rolled back on its tracks. Every group of natives appears to have its local head man; this position he attains on account of his skill in hunting or fighting, or his knowledge of the ancient traditions of the tribe; such a man will consult the elders of his tribe, but the final disposition of all points rests in his hands: no stranger will enter the camp without his permission; should he have no son to succeed him he appears to have the power to nominate the individual he desires to be his successor—in other words he is in a primitive fashion chief of his group. On the other hand, the natives do not appear to have arrived at that state where a chief of a tribe becomes a necessity. We are glad to see the authors take a stand against the common assertion that the Australian aboriginal is degenerate; no assertion can be wider the mark, for we have no evidence to show that the Australian was ever in a higher state of civilisation than that in which he is now found.

FIG. 2.—Ceremony of the Emu Totem; the head-dress represents the neck and head of an emu.

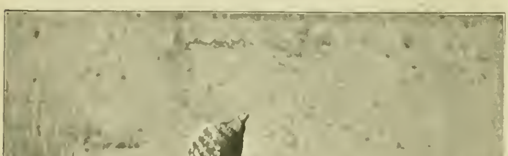


FIG. 3.—Kurdaitcha creeping up to his enemy. Between his teeth he holds a small stone Churinga; the shoes are seen on his feet, and in his left hand he holds a shield and two or three wooden Churinga.

The book, suitably dedicated to the founders of Australian anthropology, is a solid piece of work of altogether exceptional merit. In the above remarks we have only been able to point out a few of its more salient features; but there is a mass of information we have not touched upon, and which will gladden the heart of the anthropological student. The excellent illustrations of the ceremonies, evidently obtained with much care, patience and difficulty, are of considerable assistance to the text; the glossary fulfils its purpose, and the index is good.

HY. LING ROTH.

SIR DOUGLAS GALTON, K.C.B., F.R.S.

SIR DOUGLAS GALTON, whose death we regret to have to record, was for many years one of the best-known men not only in scientific circles but also in many walks of life. He was born in 1822, educated at Rugby, and entered the Royal Military Academy at the age of fifteen; here he had a most distinguished career, and obtained his commission in the Royal Engineers in 1840, taking a first prize in every subject of the examination.

He entered public life in 1847 as secretary to the Commission that investigated the application of iron to railway structures, and soon afterwards became an inspector of railways and secretary of the railway department of the Board of Trade. This position he resigned in 1860, but his knowledge of railway matters led to his still carrying out a good deal of important work in connection with railways. Perhaps the most important of these was a series of experiments for testing automatic brakes, carried out in 1878 and 1879. The results of these experiments were brought by him before the Institution of Mechanical Engineers in a series of papers, which have ever since ranked among the standard works of reference for engineers.

He also rendered most important services to submarine telegraphy, acting as chairman of a Committee appointed by the Government to investigate the reasons for the failure of the Atlantic cable of 1858, and the Red Sea and Indian cable; the report of this Committee, issued in 1861, is recognised as the "most valuable collection of facts, warnings and evidence ever compiled concerning submarine cables."

In 1860 he was appointed Assistant-Inspector-General of Fortifications, and two years later he became Assistant-Under-Secretary of State for War. After his retirement from this post he became Director of Works and Public Buildings in Her Majesty's Office of Works, an appointment which he held until 1875.

He was for twenty-five years General Secretary of the British Association, and this fact alone should win for him the gratitude of scientific men; and he only resigned that post to be appointed President in 1895. But sanitary matters especially attracted his attention. As Captain Galton he invented the grate which still goes by his name, and which introduced a new idea. He never patented this invention, so it was to no one's interest to push it; had it not been for this state of things, there is no doubt that it would long ago have come into general use, and would probably have brought a large fortune to its inventor.

He was connected with all the great sanitary undertakings of the last forty years or more. Whether it was the main drainage of the metropolis, or the improvement of the health of the army, or the training of sanitary inspectors, Sir Douglas Galton was always to the fore; in fact, no scheme connected with sanitary improvement has for many years past been considered complete without his co-operation. He strongly opposed the scheme of the Metropolitan Board of Works by which the sewage of London was discharged into the river at Barking and Crossness, urging that a nuisance would be created by it, and that it should be taken down as far as Sea Reach in order to be diluted with a much larger volume of water. The result amply justified his anticipations, and showed the correctness of his judgment.

He was one of the early supporters of the Parkes Museum, and also the leading spirit of the Sanitary Institute, of the Council of which he was chairman for the second time at his death; but to enumerate the positions he filled, and filled with distinction, would take up too much space.

He was elected an Honorary Member of the Institution of Civil Engineers in 1850, and a Fellow of the Royal Society in 1859, and received the honorary degrees of D.C.L. from the University of Oxford, and LL.D. from Durham and from Montreal. He was made a C.B. in 1865, and a K.C.B. in 1887.

Personally he was a kindly and genial man who made many friends, and few, if any, enemies, and his "amiable personality," a phrase happily applied to him by one of the foreign delegates of the International Congress of Hygiene and Demography in 1891, of the executive committee of which he was chairman, will be much missed.

W. H. C.

PROFESSOR OTHNIEL CHARLES MARSH.

JUST within a period of two years the United States has lost two of its most distinguished palæontologists, Cope having passed away on April 12, 1897, while the death of Marsh is announced to have taken place on the 18th of March of the present year. The two names have been associated (not always, unfortunately, in the most amicable manner) in connection with the marvellous discoveries of strange and gigantic creatures which have rendered the last five-and-twenty years unique in the history of palæontology; and it may be regarded as certain that none of their successors, however able they may be, will ever attain the world-wide celebrity accorded to these distinguished workers. For as Owen and Huxley are the two English biologists whose names have become household words, so Marsh and Cope are the popular representatives of Trans-Atlantic palæontological investigation.

Marsh, who was considerably the elder of the two, was the more familiarly known in England, from his custom of making periodical visits to Europe at comparatively short intervals. His last visit was to the Zoological Congress held at Cambridge during the past summer; and all those who then saw him could scarcely fail to notice that the hand of death had already made its grip on the once stalwart frame.

According to the information at present available to us, it appears that Marsh was sixty-eight years of age at the time of his decease. Born in the States, he received a large portion of his education at Yale; but he also studied geology and palæontology at various continental seats of learning, such as Berlin, Breslau, and Heidelberg, thus acquiring a wide basis of knowledge which stood him in good stead in after years. He was appointed to the chair of Palæontology in the University of Yale in the year 1866; and this important post he held till his death. For many years he was also palæontologist in charge to the U.S. Geological Survey, at first under Clarence King and then J. W. Powell; but of his subsequent relations to that department we are not fully aware. Marsh possessed the University degrees of Ph.D., LL.D., and M.A.; and his great attainments were recognised by his affiliation to many European scientific bodies. In this country, he was a Fellow of the Geological Society, having been elected as far back as 1863, and in 1877 having received the first award of the then newly-founded Bigsby Medal. In 1881 he was elected a Corresponding Member of the Zoological Society of London; and he was likewise on the roll of the British Association, whose meetings he on several occasions attended. A nephew, we believe, of the late George Peabody, Marsh was a man of considerable, if not large fortune; and to this circumstance is partly owing the vast extent of the collections he succeeded in accumulating.

Prout's discovery in 1846 in the Miocene strata of Western America of remains belonging to the animals now known as *Titanotherium* was the commencement of the investigations which made celebrated the names of Leidy, Cope, and Marsh. But it was not till 1869 that the older beds on the western flanks of the Rocky Mountains were explored, and the Eocene mammals of America thus brought to light. It was in this year that the explorations in the neighbourhood of Fort Bridger at the base of the Uinta Mountains were commenced; and it was from this district that the Uinta, Bridger, Wasatch, and Wind River beds received their names. The first worker in this field of research was Leidy, whose labours were mainly confined to the fauna of the higher Tertiary beds of the "Mauvaises Terres" to the east of the Rocky Mountains. By 1862, in which year appeared his paper on *Eosaurus* from the Carboniferous of Nova Scotia, Marsh was, however, well to the fore as a working palæontologist, and shortly after the opening-up of the Fort Bridger district as a fossiliferous locality he was almost at the zenith of his fame; the year 1872 being notable as the one in which the now well-known names *Ichthyornis* and *Hesperornis* were applied to the toothed birds of the Kansas Cretaceous. Some idea of the rapidity with which specimens were collected and described may be gathered from the fact that between the years 1862 and 1879 Marsh proposed no less than 134 new generic terms for the fossils he accumulated and described. That many of these names subsequently turned out to be synonyms, in no way detracts from the energetic character of his labours. For it must be remembered that between 1869

and 1879 he was making known not only the Uintatheres (his so-called Dinocerata) of the Eocene of the Western States, but likewise the huge Jurassic Dinosaurs like *Brontosaurus* and *Atlantosaurus*, as well as the Toothed Cretaceous birds of Kansas. It was during this period, too, that the world was excited by his discovery of the pedigree of the horse, which fortunately came just when an actual example was urgently needed to solidify the foundations of the evolutionary hypothesis.

On this side of the Atlantic we are, perhaps, too apt to regard Marsh in the light of what used to be called a closet naturalist. But he was in reality a courageous and intrepid explorer, who between the years 1869 and 1888 is stated to have crossed the Rocky Mountains no less than twenty-one times. And in the early days of his explorations, before the opening-up of the country by railways, such expeditions contained no slight elements of danger. Not only were there difficulties of the road and inclemencies of climate with which to contend, but hostile Indians were often on his track; and we have heard from the explorer's own lips accounts of some of the perils to which he has been exposed on trips of this description.

We have said that it was between 1869 and 1879 that the great bulk of the early descriptive palæontological work of Marsh took place; and by the latter date he had leisure to undertake more elaborate and detailed memoirs. Accordingly, we find the quarto monograph on "Odontornithes" making its appearance in 1880, and that on "Dinocerata" four years later. We believe that similar monographs on the Titanotheres and Dinosaurs were in contemplation, and the plates for them prepared; but for some reason, into which we need not inquire, these were never issued. A smaller memoir on the last-named group was, however, published in 1896. Whatever may be the final judgment as to the value of the literary matter in the two quarto memoirs, the beauty and exactness of their exquisite illustrations will render them of permanent value.

Twenty years after the discovery of the Bridger and Uinta beds—that is to say, in 1889—Marsh was able to announce the discovery of numerous remains of Cretaceous Mammals in the Laramie formation of Dakota and Montana. And although he was not absolutely the first to make the discovery, the number of specimens he obtained first put the occurrence of mammals in these beds on a firm footing. About this time he was also engaged in making known the gigantic Horned Dinosaurs of the Laramie, whose huge bulk and uncouth forms made them even more marvellous than their predecessors of the Jurassic.

And here it may be mentioned that Marsh by no means confined his investigations to palæontology, frequently entering upon questions of the age of strata. A remarkable instance of this is a paper urging that the British Wealden strata should be regarded as of Upper Jurassic rather than of Lower Cretaceous age; a communication which, we think, has scarcely received all the attention that it deserves at the hands of European workers.

What will be the final verdict in regard to Marsh's life-work, it is too early to attempt to forecast. As a collector and explorer he had great and unrivalled opportunities; and in this part of his task, at least, he rose fully to the occasion. He saw his opportunity of making a great name, and he took it. And yet, perhaps, this is scarcely a fair way of putting it, for there is little doubt that Marsh had a strong and innate love for his work, which would have led him to be a palæontologist under any circumstances.

Being a man of great determination and strength of will, he, like many others of the same turn of mind, could ill brook contradiction; and he was accordingly somewhat too apt to insist on his own views and hypotheses long after they had been proved incorrect or untenable. And it was probably this impatience of contradiction and correction that at times led him to mistake reiterated and dogmatic assertion of refuted statements for logical argument. That Marsh is entitled to claim a place in the very front rank of scientific workers is not likely to be urged; and there are, in truth, no grand and enduring generalisations associated with his name. At the same time, to paraphrase the words of the donors of the Bigsby and Lyell medals, he is undoubtedly one who has been of the most eminent service to palæontology, and has, therefore, deserved well of the science.

Allusion has already been made incidentally to certain acrimonious feelings connected with his work on the other side of the Atlantic. May we venture to hope that in the future his co-labourers and successors in America will endeavour to dwell on his merits rather than on his failings, and to remember that the time-honoured motto, "*De mortuis nil nisi bonum*," has not yet been superseded.

R. L.

WIRELESS TELEGRAPHY BETWEEN FRANCE AND ENGLAND.

MR. MARCONI is to be cordially congratulated upon the success which has attended his latest experiments in telegraphy without intervening wires. For several months he has been actively engaged in establishing communication by means of his apparatus between stations several miles apart. He has gradually increased the distance between the stations, and has now succeeded in exchanging messages across the Channel. The *Times* of yesterday prints the following message transmitted by wireless telegraphy from France, and the communication possesses particular interest on account of the fact that it is the first press message sent across the Channel by the wireless telegraph system.

"*Wimreux*, March 28.

"Communication between England and the Continent was set up yesterday morning by the Marconi system of wireless telegraphy. The points between which the experiments are being conducted are South Foreland and Wimreux, a village on the French coast, two miles north of Boulogne, where a vertical standard wire, 150 feet high, has been set up. The distance is thirty-two miles. The experiments are being carried on in the Morse code. Signor Marconi is here conducting the trials, and is very well satisfied with the results obtained.

"This message has been transmitted by the Marconi system from Wimreux to the Foreland."

The Dover correspondent of the *Times* states that this and other messages were received and read at the South Foreland station with as much distinctness as though the termini had been connected with wires. This is a very remarkable achievement, and one that will to some extent compensate Mr. Marconi for the trouble he has taken to bring his apparatus to that state of perfection which has led to such gratifying success. The practical value of a system of telegraphy which enables messages to be exchanged across the Channel without the use of connecting wires cannot be overestimated.

The experiments were conducted by Mr. Marconi in the presence of Colonel du Pontavice, French military attaché, and Commandant Fiéron, naval attaché in London; Captain Ferrier, representing the French Government, and M. Voisenat, of the French telegraph service. The results obtained have placed the efficiency of Mr. Marconi's instruments beyond doubt, and we may hope soon to see the establishment of a regular system of communication with the continent by means of telegraphy without connecting wires.

NOTES.

THE meeting of the International Geological Congress, which is to be held in Paris in 1900 (August 16 to 28), promises to be one of exceptional interest and success. It takes place at a time when a grand universal exhibition will attract many men of science from all countries. It represents a science of progressive character, which deals not only with the history of the earth and of the life which has existed, but furnishes the basis for geographical study, lends aid in art and manufactures, and is of essential importance in mining, agriculture, and hydrology. Subjects such as these draw men together irrespective of their nationality, and form bonds of union which political differences cannot rend asunder. The Committee of Organisation is constituted as follows: President, M. Albert Gaudry, Professor in the Museum of Natural History; Vice-Presidents, MM. Michel Lévy and Marcel Bertrand; General Secretary, M. Charles Barrois. The excursions which have been planned to follow the ordinary meeting number no less than nineteen, and they are so arranged that every important district in France and along its borders, and all formations of particular geological interest will be visited. Among the districts are the Paris Basin, the Boulonnais, Normandy, the Ardennes, Picardy, Brittany, Touraine, Dordogne, the Alps and Mount Blanc, Bordeaux, and the Pyrenees.

WE regret to see the announcement of the death of Prof. Gustav Wiedemann, professor of physics in the University of Vienna, at seventy-three years of age.

THE death is announced of M. Naudin, member of the section of botany of the Paris Academy of Sciences, at eighty-three years of age; and of Dr. Franz Ritter von Hauer, the distinguished geologist, at Vienna, at seventy-seven years of age.

AT a meeting on Monday of the Royal College of Physicians of London, Dr. William Selby Church, senior physician to St. Bartholomew's Hospital, was elected the president of the college.

SCIENTIFIC visitors to Paris at Easter will be interested to know that the Société Français de Physique will hold its annual exhibition of new apparatus and experiments on Friday and Saturday, April 7 and 8. The exhibition will be held in the rooms of the Society, 44 rue de Rennes.

THE French Minister of Public Instruction will preside at the closing meeting of the thirty-seventh Congrès de Sociétés savantes on April 8. The Congress opens at Toulouse, on April 4. The Toulouse Geographical Society has organised in connection with the Congress an exhibition of apparatus for the decimal measurement of time and angles.

A REPORT by Prof. T. E. Thorpe, F.R.S., Principal of the Government Laboratory, and Prof. Thomas Oliver, physician to the Royal Infirmary, Newcastle-upon-Tyne, concerning the employment of components of lead in the manufacture of pottery, and their influence upon the health of the workpeople engaged in that industry, has been issued as a Blue Book.

AT the last meeting of the Institution of Mechanical Engineers Mr. Arthur T. Walker, a member of the Council of the Iron and Steel Institute, was elected a vice-president in succession to the late Sir Douglas Galton.

THE *British Medical Journal* announces that Dr. T. Grigor Brodie, at present lecturer on physiology at St. Thomas's Hospital Medical School, has been nominated by the laboraratories committee of the Royal Colleges of Physicians and Surgeons to be director of the research laboratories on the Thames Embankment.

AT Monday's meeting of the Royal Geographical Society the President made the gratifying announcement that Mr. L. W. Longstaff, a Fellow of the Society, had subscribed the sum of 25,000*l.* to the fund for the scientific exploration of the Antarctic regions. A vote of thanks to Mr. Longstaff for his munificent gift, proposed by Sir Clements Markham, was seconded by Lord Lister, and enthusiastically carried. This generous donation brings the fund at the disposal of the Joint Antarctic Committee up to 40,000*l.*, which is sufficient to ensure our co-operation with Germany in 1900, but is not enough to enable the expedition to be carried out on a scale worthy of our country. It is to be hoped that the example set by Mr. Longstaff will be followed by others who think that England should take the first place in Antarctic exploration, and are in a position to enable her to do so.

IT is announced that the Russian expedition for taking meridian measurements in Spitsbergen will leave St. Petersburg on May 1. Two steamers have been placed at the disposal of the expedition by the Russian Ministries of Marine and Ways and Communications, and the Minister of Finance has granted 50,000 roubles for two years. M. Bjalinizki, the zoologist, and Dr. Bunge, the Polar explorer, will accompany the expedition, which will be under the leadership of Staff-Captain Sergievski.

THE fortieth meeting of the Institution of Naval Architects was held in London on Wednesday, Thursday and Friday of last week, the Earl of Hopetoun, president of the Institution, presiding. The annual report, read at Wednesday's meeting, states that the Council have had for some time under consideration the rules for the election of members and associates. Following the example of the Institution of Civil Engineers and of the Mechanical Engineers, they proposed that a new class should be introduced, to be called associate members, who would consist mainly of young men fully trained, but not yet holding positions of importance. The candidates must have served a four years' apprenticeship to a naval architect and shipbuilder, or must have had four years' training in a recognised naval college. This change in the rules was adopted by the meeting. The new rules will not come into force until Friday, March 24, 1900. A gold medal was presented to Prof. Captain Kriloff, for his papers on "The general theory of the oscillations of a ship on waves" and "On stresses experienced by a ship in a seaway"; and also one to Prof. Hele-Shaw, for his two papers describing his "Investigation of the nature of surface resistance of water and of streamline motion under certain experimental conditions." The annual dinner of the Institution was held at the Hotel Cecil on Wednesday evening, March 22.

REFERENCE has already been made to the new scheme for the Physic Garden at Chelsea. It is now definitely announced that the garden has been handed over to the Trustees of the London Parochial Charities, who have agreed to dedicate a sum of 800*l.* yearly to its maintenance. Under the new scheme the garden is to be administered exclusively for the promotion of the study of botany with especial reference to the requirements of general education, scientific instruction, and research in botany, including vegetable physiology, and instruction in technical pharmacology as far as the culture of medical plants is concerned. The practical management of the garden will be vested in a committee formed of representatives nominated by the Trustees of the London Parochial Charities, the Treasury, the Lord President of the Council, the Technical Education Board, the Royal Society, the Royal College of Physicians, the Society of Apothecaries, the Pharmaceutical Society, the London County Council, and the Senate of the University of London. Earl Cadogan and his successors, as representing Sir Hans Sloane, who conveyed the garden in 1722 to the Apothecaries'

Company in trust for the encouragement of botany, is also a member of the committee.

THE following are the lecture arrangements after Easter at the Royal Institution :—Prof. J. Cossar Ewart, three lectures on zebras and zebra hybrids; Prof. Silvanus P. Thompson, two lectures on electric eddy-currents (the Tyndall Lectures); Prof. W. J. Sollas, three lectures on geology: Prof. Dewar, three lectures on the atmosphere; Mr. Lewis F. Day, three lectures on embroidery; Prof. L. C. Miall, two lectures on water weeds; Mr. Louis Dyer, three lectures on Machiavelli; Mr. W. L. Brown, two lectures on to Iceland in search of health; Mr. Edgar F. Jacques, three lectures on the music of India and the East, and its influence on the music of Europe (with musical illustrations). The Friday evening meetings will be resumed on April 14, when a discourse will be delivered by Prof. A. W. Rücker on earth currents and electric traction. Succeeding discourses will probably be given by Dr. F. W. Mott, Prof. C. A. Carus Wilson, Dr. W. J. Russell, Prof. T. Preston, the Right Rev. the Lord Bishop of Bristol, Sir William Martin Conway, Mr. H. G. Wells, and others.

WE are glad to be able to announce that with March 1 the Administration of Telegraphs of Mexico have commenced the publication of daily weather charts, showing for 8h. a.m., Washington time, the state of the barometer, thermometer, and weather over that extensive country. Stations have been established in thirty-five localities, and these are augmented by a few voluntary observers. The service is organised on the principle of that of the Weather Bureau of Washington, and the system has been established primarily to meet the requirements of the Telegraph Administration, and, in the second place, to supply the Mexican Meteorological Observatory with trustworthy information. Weather forecasts are not yet issued, but no doubt the meteorological authorities will be glad to make good use of the opportunities offered. The charts are published in a new paper entitled *Boletin Telegráfico.*

IN the current number of the *Revue Générale des Sciences*, there is an interesting note on ceramic novelties, recording results of experiments promoted by the Society for the Encouragement of National Industry towards the solution of certain problems of pressing importance in the pottery industry. Under the title of "Atelier de Glatigny, Études et Notes No 1, Imprimeries Cerf à Versailles," M. Glatigny, a practical potter of repute, sets forth the lines of scientific and artistic thought that have found expression in his work. There is no attempt made to deduce general rules applicable to every branch of the trade, but a faithful record of actual experiments definitely and rigorously carried out. In a word, it is the record of an attempt to replace empiricism by careful scientific work, and as such it ought to be of especial service in this country, where rule-of-thumb still holds absolute sway. The chief points treated are: the influence of the atmosphere of the kiln on the colours produced by well-known colouring oxides; the influence of different ingredients on the dilatibility of body and glaze—a matter of the utmost importance to English potters, as one of the chief faults of their wares, the crazing of the glaze, is profoundly influenced by these factors; and, finally, the production of certain new pastes of the porcelain and stoneware type by the addition of substances such as powdered glass, oxide of zinc, magnesia, &c., to the substances commonly used for pottery pastes. One longs for the time when English potters shall publish the results of their labours in this way.

A DEPUTATION of representatives from the Decimal Association, chambers of commerce, educational institutions, and trade unions, waited upon Mr. Ritchie on Wednesday, March 22, at the House of Commons to urge upon the Government the compulsory adoption of the metric system of weights and measures on January 1, 1901. Several of the delegates described the advantages which metric system possesses, reference being made to the great waste of time involved in teaching our complicated system of arithmetic, and the loss of trade resulting from the use of a system not understood by other nations. In reply, Mr. Ritchie expressed himself in agreement with the arguments in favour of the metric system, but stated that his own view, and that of his colleagues, was that chaos and confusion would be created by the compulsory adoption of the metric system in this country, and it would be practically impossible to carry out a compulsory law on the subject. They had not only passed a law two years ago to make the metric system legal, but they had also added to their Board of Trade standards the standards for the metric system, and only seventeen of the whole of the local authorities in the country had come to verify their standards. It would be much better, if the chambers of commerce desired this system to be compulsory, that they should endeavour to popularise the system by putting it in practice. Certainly it would be an immense advantage to our export trade, and now that our merchants and manufacturers were alive to the disadvantages of the non-adoption of the new system they should do something in the way of adopting it. He had been in communication with other Government departments with the view of having it adopted compulsorily, and it was now under consideration.

DR. MARTIN FICKER, in a paper communicated to the *Zeitschrift für Hygiene*, describes an elaborate series of investigations he has made on some of the conditions affecting the vitality of certain pathogenic bacteria, especially those of cholera in artificial surroundings. To the student this paper is of importance, inasmuch as it at once indicates the spirit in which bacteriological research should be approached, and the pitfalls which beset the path of the unwary at every turn. The sense of dissatisfaction which surrounds a good deal of the work done with bacteria is due to the discrepancy which occurs in the results chronicled by different authors, and sometimes by one and the same author in the same subject. These discrepancies Dr. Ficker has sought to diminish in the future by pointing out some at least of the sources of error in such work, by calling attention to the importance of factors which are only too frequently overlooked. The memoir covers over seventy pages, and it is impossible to deal here with the numerous minute details which have been investigated by the author. Perhaps the most novel and interesting of the questions discussed is the influence exercised on bacteria by glass of different kinds in the vessels employed for their observation, a subject already dealt with in other connections by various investigators. As regards the degree of alkalinity imparted to water by glass of different origin, very wide divergence has been observed; and inasmuch as some bacteria, and notably those of cholera, are favourably affected by the alkalinity of their surroundings, this factor would certainly appear to be of importance. Various samples of glass were investigated in this connection, and marked differences were noted in the behaviour of cholera germs suspended in water in vessels of so-called Jena and other glass. Dr. Ficker's paper serves to emphasise once more how what superficially may appear to be inconsiderable trifles in detail, may be of supreme importance in determining the successful or otherwise management of bacteria.

THE stability of motion of a bicycle is a problem of the greatest interest, both practical and mathematical, which has too long remained unattacked. We are glad to see that Mr. F. J. W. Whipple, of Trinity College, Cambridge, has at last investigated this problem, and has been successful in obtaining

conclusions of a practical kind. One of the most interesting points which had to be worked out was the condition that a machine could be ridden without holding the handles. Mr. Whipple finds that there are four critical velocities connected with the stability of the motion, which he calls V_1, V_2, V_3, and V_4. For velocities greater than V_1 the motion is unstable, but may be rendered stable by a rider who turns the first wheel towards the side on which he is falling, or moves his body away from that side. The force he has to exert in the former operation is comparatively great, whereas the distance he has to move his body in the latter case is small. For velocities between V_1 and V_2 the motion is stable, even when the rider does not move his body and makes no use of the handles. For velocities less than V_2 the motion without hands is unstable, but between V_2 and V_3 it is stable for a rider who moves his body through a very small distance in the same direction as the fall is carrying him. This distance is about 1/20 of the distance he is moved by the swaying of the machine. For velocities between V_2 and V_4 the motion is stable for a rider who keeps the motion of the handles as small as possible. For velocities below V_4 a rider who combines the two methods, using both his weight and his hands, may be successful. The balance for such low velocities is not automatic, but is a feat which requires conscious attention. Mr. Whipple, considering a typical machine, obtains the following values in miles per hour: $V_1 = 12{\cdot}2$, $V_2 = 10{\cdot}4$, $V_3 = 8{\cdot}5$, $V_4 = 7{\cdot}4$. He considers that practically V_2 is the most important factor in determining the ease of riding, but unfortunately its calculation for any given machine is not easy. In connection with the effects of spinning friction, it is pointed out that a well-inflated tyre is conducive to stability. Mr. Whipple's paper appears in the *Quarterly Journal* of Pure and Applied Mathematics for March.

A NEW method of photographing in natural colours is reported by *Science* to have been discovered by Prof. R. W. Wood, of the University of Wisconsin. The colours are said to be obtained by diffraction; and, though at present the production of the first finished picture is somewhat tedious, duplicates can be printed as easily as ordinary photographs are made. The pictures are on glass, and are not only colourless, but almost invisible when viewed in ordinary lights; but when placed in a viewing apparatus, consisting of a convex lens on a light frame, show the colours of nature with great brilliancy. The principle is that the picture and the lens form spectra which overlap, and the eye placed in the overlapping portion sees the different portions of the picture in colour depending on the distance between the grating lines at that place. Prof. Wood says the finished picture is a transparent film of gelatine with very fine lines on it, about 2000 to the inch on the average. The colours depend solely on the spacing between the lines, and are pure spectrum colours, or mixtures of such, the necessity of coloured screens or pigments, used in all other processes except that of Lippmann, having been overcome. The pictures can be projected on a screen by employing a suitable lantern, or can be viewed individually with a very simple piece of apparatus consisting of a lens and perforated screen mounted on a frame. It is difficult to form an opinion upon the method or results from the information so far available, and we hope that further details will soon be published.

IT is well known that aneroids are not to be depended upon for the determination of altitudes. When an aneroid and a mercurial barometer are subjected to a diminishing pressure, brought about either by increase of altitude or experimentally by means of an air-pump, it is found to indicate a lower reading than that shown by the mercurial barometer. The lower the pressure, and the greater the length of time the diminution of pressure is experienced, the greater is the loss in any individual aneroid. As the extent of the loss of an aneroid subjected to diminished pressure depends upon the length of time during which the instrument is exposed to this pressure, evidently a way to remedy the defect is to obtain an instrument which can be put in action when required to make a determination of pressure, and put out of gear or thrown out of action when not wanted for use. An aneroid which fulfils these conditions has been invented by Colonel H. Watkin, C.B., and is manufactured by Mr. James J. Hicks. The instrument has precisely the same appearance as an ordinary aneroid, and the only addition is a fly-nut at the back, by means of which the vacuum-box can be put in action when a reading is required. This aneroid has been reported upon favourably by Mr. Whymper and other travellers, and it is certainly an advance upon the ordinary instrument. When the instrument is in action a line on the ring, to which the fly-nut is fastened, coincides with an arrow upon the case. This, we think, admits of improvement, for the coincidence cannot be very accurately determined. In taking readings before and after putting the instrument out of action, we found a slight difference on each occasion, which may perhaps be due to the difficulty in bringing the ring back to the same point.

FROM the *Journal* of the Franklin Institute we learn that the Elliott Cresson gold medal has been awarded to Mr. Clemens Herschel, and John Scott legacy premiums and medals to Messrs. Frederick N. Connet and Walter W. Jackson for their joint invention of the Venturi meter, an apparatus designed for measuring the flow of liquids in pipes of any desired dimensions up to 60 inches or more in diameter. The Venturi proper, invented by Mr. Herschel, consists essentially of a tube containing a constriction through which the water has to flow, and by measuring the difference of pressure between the wider and narrower parts, the rate of flow of the liquid can be calculated by well-known formulæ. The two last-named inventors have devised the elaborate registering apparatus driven by clockwork, whereby the indications of the piezometer are made to give a record of the total quantity of water flowing through the pipe by a species of mechanical integration or "quadrature."

THE fifth edition of the *Naturalist's Directory* for 1899, published by Mr. L. Upcott Gill, is to hand. It contains the names, addresses, and specialities of several thousand field naturalists, as well as curators of museums and professors and lecturers on natural science. The zoologists alone occupy seventy-two pages, and a rough statistical tabulation of a few pages, selected at random, shows that ornithology and lepidoptera head the list, the numbers of specialists in each of these being more than double of that in any other department; ornithology and oology when added together have the majority. Mollusca, malacology and conchology, when combined, come next in point of numbers, entomology (in general) next, and coleoptera next again. Although the other orders of insects and the other branches of zoology are mostly represented, their devotees fall greatly behind those of the afore-mentioned subjects. Microscopy occupies twelve pages, and shows a large preponderance of specialists in pond life and vegetable physiology. Diatoms and foraminifera come next, but a long way behind, in popularity; and after these, bacteria, marine zoology, biology, photo-micrography, and micro-entomology divide the favours about equally. In botany, which occupies fifteen pages, phanerogams, as might be expected, have an overwhelming majority; while among cryptogams, mosses and hepaticæ appear to be most popular. Geology and palæontology extend over thirteen pages In addition the volume contains a trade directory, a list of societies, field clubs and museums, from the Royal Society and British Museum downwards, and a list of books of the year

on natural science. The long list of names in the *Naturalist's Directory* reassures us that field natural history of the good old sort still holds its own in the matter of popularity, despite the conflicting claims of laboratory science on the one hand, and photography and bicycling on the other.

Cosmos for February 25 contains an illustrated article on Volta's discovery of the cell which bears his name, and on the exhibition to be held at Como in commemoration of the centenary of the discovery.

THE *Revue scientifique* for February 25 contains an account of a paper read before the French Association for the Advancement of Science by M. Armand Viré, on the peculiar cæcal fauna of the caves of the Jura and the Pyrenees. From it we learn that a subterranean laboratory for studying the modifications in the tactile and other organs of animals produced by darkness has been opened in the catacombs of the Jardin des Plantes at Paris, under the direction of Prof. Alphonse Milne-Edwards, and interesting results have already been obtained.

A NEW American botanical journal was started with the commencement of the current year, under the title of *Rhodora*. It is edited by Dr. B. L. Robinson, of the Gray Herbarium, Harvard University, and is brought out under the auspices of the New England Botanical Club.

SOME attention has been recently directed to the qualities of rhea or ramie-fibre (*Boehmeria nivea*) as a material for textile fabrics. In the *Agricultural Gazette* of New South Wales for November 1898, Mr. H. N. Jackson advocates its growth for commercial purposes in that Colony.

WE have received *Bulletins* Nos. 12–14 of the Geological and Geographical Commission of São Paulo, Brazil, entirely devoted to the botany of the district, and comprising monographs of the orders Compositæ, Solanaceæ, Scrophulariaceæ, Campanulaceæ, Cucurbitaceæ, Calyceraceæ, and Valerianaceæ. The diagnoses of the species, and even the characters in the claves to the genera, being entirely in Spanish, and not in Latin, renders it difficult to estimate the scientific value of the work, and at all events detracts from its usefulness.

A CATALOGUE of valuable works on many branches of science, and including the *Transactions* of a number of learned societies, has been issued by Mr. B. Quaritch, who offers the works for sale.

MESSRS. WILLIAM WESLEY AND SON have issued a new number of their "Natural History and Scientific Book Circular," containing a classified catalogue of nearly two thousand books and pamphlets on geology, including works from the libraries of the late Mr. W. Topley and Mr. Richard Meade.

THE *Transactions* of the Leicester Literary and Philosophical Society (vol. v. part iii., January 1899) contain a presidential address delivered by Mr. A. Colson on electricity and its uses, and papers on ovules, by the Rev T. A. Preston, and on the structure and life-history of the cockroach, by Mr. W. J. Hall.

AMONG the lectures to be given during April at the Royal Victoria Hall, on Tuesday evenings at 8.30, are the following:—April 4 (Easter Tuesday): Mr. W. H. Shrubsole, on "Switzerland, past, present, and future." April 11: Mr. F. W. Rudler, on "The Geology of London." April 18: Prof. Lloyd Morgan, on "Instinct and Intelligence in Animals."

THE fifth volume of the *Annales du Bureau des Longitudes* (Gauthier-Villars et Fils), which is dated 1897, but has only recently come to hand, contains several memoirs of interest. The first of these consists of a very complete account of the work done in determining the differences of longitude between San Fernando, Santa Cruz de Tenerife, Saint-Louis, and Dakar, besides a set of measures for determining the value of *g*, by Messrs. Bouquet de la Grye, Cecilio Pujazon, and Driencourt. This mission, it may be remembered, commenced its work in the year 1885, and was supplied with an excellent set of instruments. In the succeeding memoir, M. Bigourdan reports on the astronomical, physical and meteorological observations made at the camp at Joal (Senegal) during the total eclipse of the sun on April 18, 1893. The report contains a full account of the measurements for determining the position of the station, besides numerous tables and diagrams of the meteorological observations. From the astrophysical point of view the next report, by M. Deslandres, on his observations of the same eclipse is, perhaps, of more interest. M. Deslandres' equipment was chiefly spectroscopic, and he made great use of photography. In his report, he points out very clearly the necessity of such spectroscopic observations for settling and advancing certain questions relative to the solar atmosphere; and in Chapter iv. briefly summarises the history of hypotheses to explain the origin and different forms assumed by the corona. The memoir is accompanied by some fine heliogravures of the eclipse station and the corona. The last section of this volume is devoted to a report on the international conference on fundamental stars, which took place in 1896, including Dr. Gill's propositions for the values of astronomical constants.

IN the year 1896, although many observing parties went to several places along the line of totality from which the total solar eclipse of August could be observed, it turned out that, owing to extremely bad weather conditions, only those who went to Novaya Zemlya were fortunate enough in obtaining observations. The late Sir George Baden-Powell, it will be remembered, took a small party of English observers in his yacht to that region, and it was there also that a party of Russian observers had taken up their station. A very detailed account of the work done by this latter expedition has just come to hand, and it will be found in vol. viii. (No. 1) of the *Memoirs of the St. Petersbourg Imperial Academy of Sciences* (Physical Mathematical Class). In addition to the astronomical observations referred to in this volume, there are given descriptions of the surveys and collections made by the expedition to their station. The volume contains numerous beautiful illustrations of the eclipse station, groups, rock-formations, glaciers, together with numerous large scale maps of the region traversed. Unfortunately, the whole memoir is published in the Russian language, so its utility will to a great extent be restricted.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*), a Levaillant's Cynictis (*Cynictis penicillata*) from South Africa presented by Mr. J. E. Matcham; two Black-backed Jackals (*Canis mesomelas*) from South Africa, presented respectively by Mr. William Hare and the Trustees of the South African Museum; a Golden Agouti (*Dasyprocta aguti*) from South America, presented by Dr. G. L. Johnson; a Tawny Owl (*Syrnium aluco*), European, a Common Kestrel (*Tinnunculus alaudarius*), British, presented by Lady Evelyn Riddell; a White-tailed Eagle (*Haliaetus albicilla*) from Northern Asia, a Great Black-headed Gull (*Larus ichthyaetus*) from Western Asia, presented by Dixon Bey; a Suricate (*Suricata tetradactyla*) from South Africa, deposited; two Coscoroba Swans (*Coscoroba candida*) from Antarctic America, a Long-tailed Duck (*Harelda glacialis*), North European, purchased; a Hybrid Macaque Monkey (between *Macacus cynomolgus*, ♂, and *Macacus rhesus*, ♀), a Crested Porcupine (*Hystrix cristata*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN APRIL :—

April 1. 14h. Saturn in conjunction with moon. Saturn $2° 16'$ North.
5. Pallas in opposition to the sun.
7. 16h. 30m. Transit (ingress) of Jupiter's Sat. III.
13. Perihelion passage of Swift's comet (1899 *a*).
15. Venus. Illuminated portion of disc = 0·750.
Apparent diameter = $14''·6$.
Mars. Illuminated portion of disc = 0·900.
Apparent diameter = $7''·5$.
15. 11h. 26m. to 12h. 8m. Occultation of μ Geminorum (mag. 3·2) by the moon.
15. 12h. 35m. Minimum of Algol (β Persei).
17. 10h. 44m. to 11h. 8m. Occultation of 3 Cancri (mag. 6·0) by the moon
18. 9h. 24m. Minimum of Algol (β Persei).
19. 9h. 10m. to 10h. 14m. Occultation of *h* Leonis (mag. 5·4) by the moon.
20. Epoch of Lyrid meteoric shower (radiant $271° + 33°$).
22. 11h. 12m. to 12h. 20m. Occultation of B.A.C. 4006 (mag. 5·7) by the moon.
24. Ceres in opposition to the sun.
25. 7h. Jupiter in opposition to the sun. At this time the planet will be about 1° from λ Virginis (mag. 4·6).
Polar diameter of Jupiter = $41''·2$.
26. Ceres about ½° N. of ϕ Virginis (mag. 5).
26. 9h. 53m. to 11h. 1m. Occultation of B.A.C. 5023 (mag. 5·8) by the moon.
27. Predicted date of perihelion passage of Holmes's periodical comet (1892 III.).
28. 11h. 56m. to 13h. 6m. Occultation of θ Ophiuchi (mag. 3·4) by the moon.

The planet Jupiter will be well visible during the month, though his position is about 12 degrees south of the equator. The remarkable hollow in his great southern equatorial belt, and the remains of the famous red spot of 1878–81, may be observed on or very near the central meridian of the planet at the following times :—

	h.	m.		h.	m.
April 7	11	31	April 19	11	23
12	10	38	24	10	30
17	9	45	29	9	38

Saturn will be conspicuously displayed in the morning sky, and rises before midnight after the middle of the month. Considered as a telescopic object, however, his low position, nearly 22 degrees south of the equator, is a disadvantage, and will seldom allow the details of his surface to appear well defined.

ORBIT OF COMET 1896 III. (SWIFT).—Prof. R. G. Aitken, of the Lick Observatory, has collected all the observations of this comet that were available, and, after a thorough discussion, has made a definite determination of the orbit (*Ast. Nach.*, Bd. 148, Nos. 3550–51). The elements prove to be hyperbolic, and are as follows :—

$$T = 1896,\ \text{April } 17·6473143,\ \text{G.M.T.} \pm 0·00057326\text{d.}$$

$$\left.\begin{aligned} \pi &= 179°\ 59'\ 15''·40 \pm 3''·95 \\ \Omega &= 178\ \ 14\ \ 51·48 \pm 6·74 \\ i &= 55\ \ 34\ \ 24·69 \pm 8·88 \end{aligned}\right\}\ \text{M. Eq. } 1896·0$$

$$q = 0·5662857 \pm 0·00001347.$$
$$e = 1·0004757 \pm 0·00009985.$$

SATURN'S NINTH SATELLITE.—A few further particulars respecting Prof. W. H. Pickering's important discovery are now to hand. The instrument used was the new photographic doublet, 24 inches aperture and about 160 inches focus, which was presented to the Harvard College Observatory by Miss Catherine Bruce. Attempts have been made in previous years to find satellites by photography, but these turned out unsuccessful in consequence of the relatively low rapidity of the lens. Last summer, however, the attempt was again made at the Harvard Observatory at Arequipa, Peru, with this new extremely rapid lens. The four successful photographs were taken on the nights of August 16, 17 and 18, 1898, each plate being exposed for about two hours. The number of stars shown on a plate is estimated as 100,000.

In searching for the satellite two plates were placed film to film, so that each star was indicated by two dots. On the first two plates examined an isolated point was found near the planet. A similar isolated point was found on each of the other plates but in different positions with respect to the stars. The plates having been taken at an interval of two days, Saturn had moved in its orbit, and the images on the plates being found to have moved in the same direction, this furnishes strong evidence of the reality of their being due to a satellite and not to accidental defects of the plates. The new satellite is so faint that there is little possibility of its observation with any but the largest instruments.

MEASURING EXTREME TEMPERATURES.[1]

II.

Extension of the Range of the Gas-Thermometer.

THE methods of measurement so far considered are in a certain sense *arbitrary* in so far as they depend on extrapolation of empirical formulæ. If all these methods could be reduced by direct comparison to perfect agreement with each other, a definite scale of temperature would be attained to which all measurements could be referred, and which would leave nothing to be desired from a purely practical point of view. It is probable that this scale would not differ much from the theoretical or absolute scale of temperature. For theoretical investigations, however, without which no true scientific advance can be made, it is a matter of such fundamental importance to refer every measurement to the absolute scale, that no opportunity should be neglected of extending the possible range of accurate observation with the gas-thermometer, because this instrument affords at present the closest approximation to the absolute or theoretical scale. A consideration of the difficulties of the methods of gas-thermometry at present in use will lead naturally to the best methods of extending the range and accuracy of the instrument.

Defects of Bulb-Methoas.

In the ordinary method of gas-thermometry a *bulb* containing the gas is exposed to the temperature to be measured, and the observation consists in determining either the expansion of volume or the increase of pressure of the gas. The principle is very similar to that of the ordinary liquid in glass thermometer, but the apparatus is more cumbrous and difficult to use on account of the necessity of observing both the volume and the pressure of the gas. This method is very accurate at moderate temperatures, but the difficulties increase very rapidly above 1000° C. Above 1200° C. it is doubtful whether such measurements are of any greater value than those obtained by extrapolation. Apart from the difficulty, which is common to nearly all methods at high temperatures, of maintaining a uniform and steady temperature, the bulb-method of gas thermometry is liable to the following special sources of error.

(1) Changes in volume of the bulb.
(2) Leakage and porosity.
(3) Occlusion or dissociation.

In order to investigate these sources of error a special form of porcelain air-thermometer (Fig. 3) was designed by the writer, and was constructed in Paris in December 1886, under the supervision of W. N. Shaw, F.R.S., of Emmanuel College, Cambridge. A figure and description of this instrument were published in the *Phil. Trans.* A., 1887. The same form has since been adopted by MM. Holborn and Wien in their experiments on the measurement of high temperatures at the Reichsanstalt. Thick tubes of 3 sq. mm. cross section, marked AC, BD in Fig. 3, were connected at each end of the cylindrical bulb BA. The length CD could be directly observed at any time with reading microscopes, and the linear expansion of the bulb could be deduced. The volume of the bulb could also be gauged at any time with air, and the mean temperatures of the separate portions AB, AC, BD, could be determined by means of platinum wires extending along the axis of the instrument. This was a most essential part of the apparatus, as the wires afforded a means of accurately reproducing any given set of conditions, and of testing the performance of the gas-thermometer at high temperatures in respect of all the various sources of error above mentioned. (1) It was observed that the volume of the bulb underwent continuous changes, chiefly in the direction of contraction, and that the shrinkage was not symmetrical, being apparently greater in the circumference than in the length of the cylinder. (2) To prevent leakage, and to close the pores of the material, it is

[1] Discourse delivered at the Royal Institution, on March 10, by Prof. H. L. Callendar, F.R.S. (Continued from p. 497.)

necessary to have the porcelain bulb glazed both inside and out. The glaze becomes sticky, and begins to run at a temperature below 1200° C., and the bulb begins to yield slightly and continuously to pressure above this point. (3) With some gases there appear to be slight traces of chemical action or occlusion of the gas by the walls of the bulb at high temperatures. It is for this reason preferable to use the inert gases nitrogen or argon as the thermometric material In any case, the limit of high temperature measurement would be reached when either the gas, or the material of the bulb, began to dissociate or decompose. Deville and Troost, employing CO_2 for filling the porcelain bulb, found the temperature of the B.P. of zinc nearly 150° higher than with air or hydrogen. This they attributed to a partial dissociation of the CO_2 at the temperature as low as 930° C. Some experiments made by the writer appeared, however, to indicate that the effect was due to chemical action between the gas and the porcelain.

For these and other reasons it appears very doubtful whether any improvement or extension of range can be expected from the use of glazed porcelain. If an attempt is made to employ any of the more refractory kinds of fire-clay, there is the difficulty of finding a suitable glaze, and of eliminating leakage and porosity. The writer suggested the use of bulbs of fused silica some years ago (*Proc.* Iron and Steel Institute, 1892), and endeavoured to get such bulbs constructed, but without success. This material possesses many of the requisite qualities, but is for this very reason extremely difficult to work. Metallic bulbs of platinum or platinum-iridium are by far the most perfect in respect of

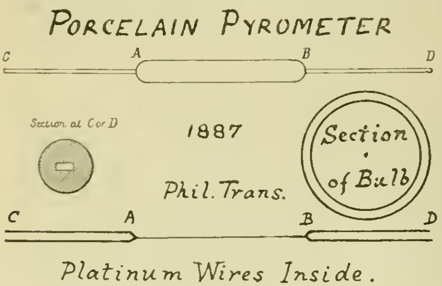


Fig. 3.

constancy of volume, regularity of expansion, and facility of accurate construction; but unfortunately, as Deville and Troost showed, they have such an inveterate tendency for occluding or dissolving gases at high temperatures, that the use of metallic bulbs has been practically discontinued, in spite of their obvious advantages in other respects.

Advantages of "Resistance"-Methods.

After making many vain experiments, the writer was forced to the conclusion that the ordinary bulb-methods did not promise any satisfactory solution of the problem of extending the range of the gas-thermometer, and that it was necessary to attempt a radically new departure. The optical method, depending on the measurement of the refractivity of a gas at high temperatures, and the acoustical method, depending on the observation of the wave-length of sound, although of great theoretical interest, did not appear to promise sufficient delicacy of measurement or facility of practical application. Experiments were therefore made on the methods of effusion and transpiration, which had been occasionally suggested by previous writers, but have not as yet, so far as the author is aware, been practically investigated as a means of measuring temperature on the absolute scale. The method of effusion consists in observing the resistance to the efflux of gas through a small hole or orifice in a thin plate. In the method of transpiration the gas is made to pass through a fine tube instead of a small orifice, and the resistance to its passage is observed in a similar manner. These methods may be called "resistance-methods" to distinguish them from the ordinary or "bulb-methods" of pyrometry. They are closely analogous to the now familiar resistance-method of electrical pyrometry, and possess many of the advantages of that method in point of delicacy and facility of application. One very obvious and material advantage, especially for high temperature work, is the smallness and sensitiveness of the instrument as compared with the bulb of an ordinary gas-thermometer. But the most important point of difference, which led the writer to the adoption of these methods, is that the measurements are practically unaffected by occlusion or evolution of gas by the material of the tubes. There is a *continuous* flow of gas through the apparatus. This flow is very large in proportion to any possible leakage, and it is therefore possible to employ platinum tubes with perfect safety.

The Method of Effusion.

The method of effusion may be very simply illustrated by means of a fine hole in the side of a large and thin platinum tube which is heated by an electric current. The current of air is heated in its passage through the tube before it effuses through the orifice. The heated air expands in volume, and the resistance to effusion is increased in proportion to the temperature to which the air is heated. The increase of resistance may be shown by means of a gas-current-indicator or "rheoscope," which consists of a delicately suspended vane deflected by a current of gas. A mirror is attached to the vane, and the deflection is measured by the motion of a spot of light reflected on to a scale, exactly as in the case of the mirror galvanometer, when used for indicating changes of electrical resistance. As a standard of comparison, to show the changes of temperature of the tube, the changes of electrical resistance of the same tube are simultaneously shown by means of a suitable ohmmeter.

The method of effusion is a beautifully simple method, and gives a nearly uniform scale; but it has two disadvantages, which it shares with the thermo-electric method of measurement. (1) It necessarily measures temperature at a point, namely at the point of effusion, and cannot be easily arranged to give the mean temperature throughout a space. (2) It is difficult to make the effusion resistance sufficiently large for purposes of accurate measurement. A large resistance means a very fine hole, and it is not easy to satisfy the theoretical conditions of the problem with sufficient accuracy and eliminate the effects of viscosity.

The Method of Transpiration.

The method of transpiration is more complicated, and does not give so uniform a scale, or so simple a formula. It has the great advantage, however, that the theoretical conditions of flow may be realised with unlimited accuracy, and that the transpiration resistance can be measured with a degree of precision very little, if at all, inferior to the corresponding electrical measurement.

The complication of the transpiration problem arises from the fact that the flow depends on the increase of the viscosity of the gas, as well as on its expansion. The viscosity of liquids in general decreases very considerably with rise of temperature. That of water, for instance, is six times less at the boiling point than at the freezing point. If the viscosity of gases diminished in a similar manner, it might happen that the transpiration resistance would decrease with rise of temperature. Maxwell was the first to give a theoretical explanation of the behaviour of gases in this respect. On certain simple kinetic assumptions, he showed that the viscosity should increase in direct proportion to the absolute temperature. Since the expansion follows the same law, the transpiration resistance on Maxwell's hypothesis should increase in proportion to the square of the temperature. This would give a fairly simple formula, and would make the transpiration thermometer a very sensitive instrument, but the scale would be far from uniform. Maxwell made some experiments on the temperature variation of the viscosity between 0° and 100° C., which appeared to give support to his mathematical assumptions; but his apparatus did not happen to be of a very suitable type for temperature measurement, and it is clear that he did not regard this part of his experimental work with great confidence.

The question of the viscosity of gases was next attacked with great vigour in Germany by a number of different physicists. They ultimately succeeded in proving that the law was not quite so simple as Maxwell had supposed, and that the rate of increase of viscosity was less than that of volume. A summary of some of the principal results obtained, over the range 0° to

100° C., is given in the following table, in which the rate of increase is expressed by finding the power n of the absolute temperature T to which the viscosity is most nearly proportional. The most concordant results were obtained by the method of transpiration, and gave an average of ·76 for the index n in the case of air. The more condensible gases gave larger values for the rate of increase, but the value for hydrogen appeared to be smaller.

TABLE III.—*Variation of Viscosity v with Temperature T. Formula, $v/v_0 = (T/T_0)^n$.*

Observers.	Dates.	Values of Index n (0° to 100° C.) Air.	O_2.	H_2.	CO_2.
Maxwell...	... 1866	1·00			
Meyer ...	... 1873	·61 – ·83			
Puluj ...	... 1874	·47 – ·65			
Obermayer	... 1875	·76	·80	·70	·94
Wiedemann	... 1876	·73			·93
Warburg	... 1876	·74 – ·77		·63	
,, and Kundt	1876	·72		·69	
Holman...	... 1876	·74 ·80			

It will be observed that the results are not very concordant, but the experiments are much more difficult and liable to error than might be supposed. The most accurate method was that employed by Holman, but even in this case the margin of uncertainty is considerable. It would evidently be impossible to employ the method of transpiration to any advantage for the determination of temperature unless a far higher order of accuracy could be easily attained. After repeating the majority of the more promising methods in detail, including the original method of Maxwell, the writer came to the conclusion that they were entirely unsuitable for the purposes of thermometry, and would have abandoned the attempt entirely if he had not fortunately succeeded in finding a more perfect way.

Application of Electrical Analogies.

In studying the flow of electricity through conductors, which is in many respects analogous to that of a fluid through a fine tube, electricians have been compelled, from the intangible nature of the fluid with which they work, to elaborate the most delicate and powerful methods of investigation. One of the most useful of these methods is generally known as the Wheatstone-bridge method, and is used for measuring the resistance of a conductor to the passage of an electric current. The method is equally applicable and equally exact for determining the resistance of a fine tube to the passage of a gas. The writer was already very familiar with the application of this method in all its refinement of detail to electrical resistance thermometry. The suggestion for applying it to the closely analogous problem of transpiration was supplied by the researches of W. N. Shaw, F.R.S., who had already applied it, in connection with certain experiments on ventilation, to the effusion of air through large orifices at ordinary temperatures.

Shaw's Effusion Balance.

The apparatus used by Shaw (described in the *Proc. Roy. Soc.*, vol. xlvii., 1890) consisted of boxes to represent rooms, with apertures about half a square inch in area to represent ventilators. Two of these apertures were made in the form of adjustable slits. The circulation of air through two rooms in parallel was maintained by a gas burner, and the slits were adjusted to make the pressure in the two rooms the same, as indicated by the absence of flow in a connecting tube, containing a pivoted needle and vane as a current detector. The balance was shown to be independent of the air-current when that was varied from one to four cubic feet per minute. The effusion resistance of an aperture was also verified to be approximately proportional to the square of the reciprocal of the area, with apertures of similar shape. This method of investigation was admirably adapted to problems in ventilation, in which the phenomena depend mainly on effusion through relatively large apertures. It would, however, be difficult to adapt to the problem of temperature measurement. It would not be easy to make an aperture which could be continuously varied without changing its shape, and at the same time to measure the change of area with sufficient accuracy, if the area were small enough to prevent appreciable cooling of the thermometer by the current of air flowing through it. There is also the disadvantage that the pressure-difference varies as the square of the current; so that, if very small currents are used, the effects of viscosity become more important, and the balance ceases to be independent of the current, unless everything is symmetrical and at the same temperature in corresponding parts.

For these reasons it seemed preferable, in applying the Wheatstone-bridge method to air-currents, to employ fine tubes as resistances, and to eliminate the effects of effusion as completely as possible, at least in the resistance-measuring part of the apparatus. With transpiration resistances the current is directly proportional to the pressure difference, the electrical analogy is much closer, and the theoretical conditions can be very accurately realised.

The Transpiration Balance.

The Wheatstone-bridge method of measurement proved to be so exact and so perfectly adapted to the problem of transpiration thermometry, that, after some preliminary experiments, the writer had a very elaborate apparatus constructed, in the year 1893, which was in every detail the exact analogue of an electrical resistance thermometer. The fine wire resistances of the electrical apparatus, in terms of which the change of resistance of the thermometer is measured, are replaced in the transpiration box by a graduated series of fine tubes, which can be

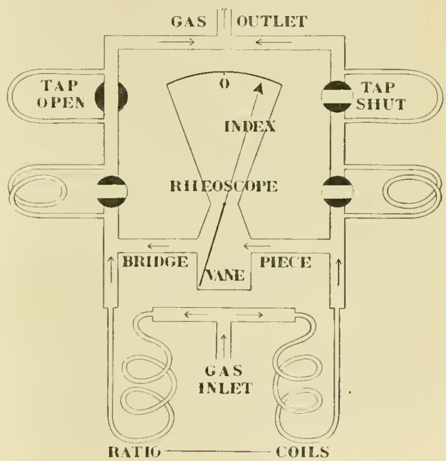


FIG. 4.—Diagram of transpiration balance.

short-circuited by means of taps of relatively large bore, corresponding to the plugs of negligible resistance in the electrical resistance box. The galvanometer is replaced by a rheoscope, constructed after a pattern devised by Joule for a different purpose, which can be made to rival in delicacy the best modern electrical instruments. The pyrometer itself consists of a fine tube of platinum instead of a wire, and is fitted with "compensating leads" to correspond with those of the electrical instrument. All the details of the methods of observation and calibration are faithfully copied from the electrical apparatus, and the result, so far as the measurement of transpiration resistance is concerned, are equally satisfactory.

Fig. 4 is a diagram of a working model of the transpiration balance, which was exhibited at the lecture. This model has a vertical needle for index, and a pivoted mica vane, which is deflected when a current flows through the bridge piece. It is constructed to work on the ordinary lighting-gas pressure, and to give its maximum deflection for a 10 per cent. change of resistance with the gas about half off. With all the taps off, the resistances on either side are equal, and there is no deflection. In the diagram the balance is supposed to have been disturbed by opening one of the taps. The apparatus actually used for temperature measurement has sixteen taps, and a mirror rheoscope, and is a thousand times more sensitive.

Variation of Viscosity with Temperature.

In order to apply the method to the measurement of extreme temperatures, it is not sufficient to be able to measure resistance. It is also necessary to determine the law of the variation of viscosity with temperature. Here, again, recourse must be had to the method of extrapolation. Fortunately, in the present instance, the temperature can be measured through a very wide range, and the range of extrapolation, being limited by the melting point of platinum, is not very great in comparison. It should be possible therefore, by sufficiently varying the conditions of the experiments, and by comparing the behaviour of different gases throughout the whole range of temperature, to arrive at a very fair degree of certainty with regard to the essential nature of the phenomenon. Owing to want of leisure for the work, the author's experiments have not as yet extended over a sufficient range of temperature, except in the case of air, to warrant the publication of any general conclusions with regard to the law of variation of viscosity, or of any results at high temperatures obtained by the method of extrapolation. It may be stated, however, that the formula above quoted, according to which the viscosity varies as some power n of the temperature, though fairly exact over a moderate range of temperature, fails entirely when tested at higher points. The results of Obermayer appear to be the most accurate for the different gases between 0° and 100° C., but if the same formula is retained, the value of the index n diminishes as the temperature is raised. Taking the average value between 0° and 100° for air as being 0·76, the value falls to 0·70 between 100° and 450°. A result of this nature was found by Wiedemann, but the rate of diminution which he gives appears to be far too great. He gives, for instance, the value $n = 0{\cdot}67$ for air between 0° and 184°, which implies a rate of diminution of the index many times greater than that which actually occurs. It would be very difficult by the method which he employed to make sure of *any* deviation whatever from the formula over so small a range, and since the error of his determination is much greater than that of the formula, he can hardly be said to have disproved the index law.

The problem is seriously complicated by the failure of the simple formula; but since the measurements are capable of great exactitude, and since it is possible to obtain many independent checks by comparing the results of the two methods of effusion and transpiration, and also by examining the behaviour of different gases, the author is confident of ultimate success. The method of experiment here described has already led to many promising and interesting results, and it is probable that the complete solution of the problem when attained, besides leading to more accurate determinations of extreme temperatures, may also throw light on dissociation and on many other points which are at present obscure in the theory of gases.

CENTRAL AMERICAN ARCHÆOLOGY.[1]

OWING to difficulties raised by the Honduras Government, the directors of the Peabody Museum have unfortunately been obliged, since the year 1895, to suspend work at the ruins of Copan, and Mr. Gordon, the leader of their expeditions in Honduras, was directed to turn his attention to other points of antiquarian interest in the neighbourhood. His reports to the Museum are now published.

In April 1896, and June 1897, an examination was made of some caverns which had been discovered in the limestone cliffs rising abruptly from the rocky bed of a mountain stream, distant about four miles from the ruins of Copan. The nature of the ground made the entrance of the caves very difficult and somewhat dangerous of approach.

In one of the chambers, nearly circular in shape and measuring 150 feet in diameter, "an excavation 20 feet long and 3 feet wide was made. After the surface layer of dust came a thin crust, which must have been caused by the presence of moisture at some period. It was only a few inches in thickness, and beneath it the material was very dry, soft, and loose, so that the men were able to remove it easily without the use of picks. In the surface crust and beneath it to a depth of three feet were found ashes, charcoal, and potsherds. The latter are not numerous, and are of a coarse quality. At a depth of three feet the potsherds and ashes and all signs of occupation disappeared; the material excavated grew lighter in colour, softer and looser. In appearance and behaviour it resembled quicklime, of which it largely consisted. Throughout the whole excavation the material removed rose in the air in thick clouds of suffocating dust. The excavation was carried to a depth of fifteen feet, where the bottom of the cavern was reached in part of the excavation. On the rock floor were absolutely no traces of occupation."

In a long passage, measuring about 80 by 20 feet, where the floor seemed to be more uneven than in the other chambers, and gave way to the pressure of the feet with a crushing sound, Mr. Gordon discovered that he was walking over the crumbling human bodies mingled with ashes and lime. A mass of charred and calcined bodies occupied the entire floor to the depth of about two feet, and the thick clouds of unsavoury dust, added to the stifling heat, made the work of examination most difficult and disagreeable. The chamber appears to have been used as a place for depositing the remains after they had been partly cremated elsewhere. None of the caves show any signs of recent occupation, but the condition of bones and of a wooden object, which was discovered, do not seem to Mr. Gordon to indicate any great antiquity. The excavations yielded no specimens of personal ornaments, or of carved stonework, and the pottery, of which several pieces were preserved entire, proved to be entirely different in character from that found in the neighbouring ruins of Copan. Mr. Gordon does not, however, think that the facts disclosed from the examination of the caves suffice to prove the existence of another race. "May it not be," he says "(to hazard a guess), that these cave relics belong, after all, to the same period as Copan itself, and are remains of the Copan people, or the devotees of some old cult among them whose temples were the caves, and whose vessels used in the ritual were of a design and character exclusively their own?"

In May and June 1896, and from March to June 1897, Mr. Gordon was occupied in examining the valley of the Uloa River, which flows northward through a forest-covered plain to the Gulf of Honduras. Above ground only a few vestiges of a former population are to be found, and the principal group of mounds, which was examined, yielded only one example of sculpture—namely, a very rough stone idol similar to the rude stone sculptures found in Nicaragua. However, during the rainy season the river cuts into its banks, and frequently leaves exposed to view cross sections of unconsolidated strata of sand and clay about thirty feet in height, which in some cases "present the continuous spectacle of broken pottery and fragments of bone from the surface of the water to within a few feet of the top. In places these objects are very numerous for stretches of several hundred feet, then diminishing gradually and almost disappearing for miles."

The principal excavations were made near the village of Santana, about twenty-five miles in a straight line from the mouth of the river. The objects found, consisting chiefly of fragments of pottery, were met with in distinct layers a few feet in thickness, separated by other layers, which also contained a few objects, but in much smaller numbers. In excavation No. 3, for instance, there were three principal layers at depths of twelve, twenty, and twenty-five feet; the last, in this case, by far the most extensive of the three. The pottery shows no signs of water-wearing, and it seems probable that the various articles "must have been put underground in the customary way in connection with burials, but not to the depth at which they are found at present. These burials must have been made during successive periods of occupation, separated by a series of inundations, each of which raised the general level of the ground several feet by the deposition of detritus from the mountains."

From an examination of the large collections which were made, Mr. Gordon is of opinion that the natives of this valley had attained a proficiency in the art of pottery not exceeded in any other part of Central America, and although the specimens display great variety in character, it is evident that the dominant influence was Maya. The absence of architectural remains, the most familiar and remarkable feature of Maya culture in other regions, he attributes to the absence of any available supply of building-stone in the valley of the Uloa.

"It is among the pottery vessels that the Maya affinities are

[1] "Memoirs of the Peabody Museum of American Archæology and Ethnology, Harvard University," Vol. i, Nos. 5–6. Researches in the Uloa Valley, Honduras; Caverns of Copan, Honduras. By George Byron Gordon.

most prominent. Of the number represented, either by entire specimens or by fragments, not only do the greater part exhibit technical qualities identical with the pottery from Copan, but especially in the conventional use of certain decorative motives, and in the employment of a graphic system common to that of the Codices and to the sculptured monuments of Maya, these affinities are very manifest. The same relationship makes itself felt, although in a less striking manner, in the other classes of objects. It is not claimed that this relationship, however intimate, covers the whole ground, or that there is any homogeneity throughout the whole body of ceramic products, as if it were the work of a homogeneous people and represented a culture developed from within. On the contrary, there is in the tendency towards diversity of type strong evidence of an admixture of races, or of extensive importations derived from a variety of sources."

The relation which the art of the Uloa Valley and the other confines of the Maya area bears to that of the great central Maya ruins is a matter of the deepest interest to archæologists. Although it is much to be regretted that Mr. Gordon is prevented from continuing his interesting researches amongst the ruins of Copan, it is no small satisfaction to know that he has found other work to do, in which his knowledge of Maya art will be fully utilised.

A most interesting series of photographic and other plates accompanies the "Memoirs."

A NEW VERTICAL COMPONENT MICROSEISMOGRAPH.

THE microseismograph, devised a few years ago by Prof. Vicentini, of Padua, is now well known as one of the most valuable of the vertical pendulums used in Italy for recording earthquake movements. With the aid of Dr. G. Pacher, several improvements have been made in it, the latest being the construction of a microseismograph for recording the vertical component of the motion (*Atti del R. Ist. Veneto di scienze*, &c., vol. lvii., 1899, pp. 65-89). In many of the details, it closely resembles the older instruments adapted for the horizontal components only. The chief points in which it differs from the latter are the following. The pendulum consists of a bar of iron 1·50 m. long, 75 mm. wide, and diminishing in thickness from 10 mm. at one end to 7 mm. at the other. Near the thin end the bar carries three discs of lead, weighing altogether about 45 kg. The other end is fixed in a bracket built into the wall, and so inclined that the bar, under the action of the heavy mass, is horizontal at the free end. The magnifying and recording apparatus consists of two levers made of aluminium tube. One of these, bent at right angles (the longer arm being vertical), is connected with the pendulum, and transforms its vertical movements into horizontal ones. The second lever is horizontal, and its longer arm ends in a fine thread of glass, the point of which records the movements of the pendulum, magnified about 130 times, on a strip of smoked paper which passes below it at the rate of 24 mm. per minute. The first experiments showed that for rapid vibrations the heavy mass remained in a practically stationary condition. Every passing carriage produced a group of rapid vibrations, with periods varying from one to two-tenths of a second. During the short time in which the instrument has been at work, several earthquakes have been registered, and Drs. Vicentini and Pacher have increased the interest of the vertical component records by appending also those of two other microseismographs, giving the horizontal components only. These show that the vertical movement predominates during the whole of the time when the ground vibrates rapidly in a horizontal direction; and that the same sudden changes of intensity characterise the seismograms of both apparatus. The new instrument also records the slow pulsations which follow the rapid vibrations, but much less distinctly than the vertical pendulums, and it consequently sooner attains a state of rest.

THE STUDY OF WAVES.

A CLAIM for the recognition of the study of wave structures of the earth's surface as a distinct and not unimportant branch of geography was advanced by Mr. Vaughan Cornish at the Royal Geographical Society on Monday. For the study he proposed the name kumatology, from κῦμα, a wave. Mr. Cornish illustrated numerous forms of waves by means of lantern slides, and described in detail some curious waves, of which photographs were shown, which travelled up-stream, not as a "bore," but without change or form. These may be observed in streams which plough their way through sandy beaches to the sea. The water-wave was really controlled by a submerged sand-wave, the up-stream flank of which was exposed to a heavy shower of sand from the turbid water. The stream being shallow and its surface in waves, the crest of the water-wave was pushed up-stream as the up-stream flank of the sand-wave received additions of material. The scour of the water was thereby deflected, and the lee slope of the sand-hill was scoured away just as fast as the weather slope grew. Thus the sand-hill moved up-stream, although every particle of sand and every particle of water travelled down-stream. Mr. Cornish showed photographs of ripple-marks mimicking organic forms, and of rippled clouds, and the ripple-ridging of hill-sides, and went on to deal with the rippling of sand by wind, of which he has made a special study. Tables of measurements were exhibited which proved that the shape of these ripples was approximately constant for wave-lengths from 1 to 145 inches. The shape was the same in desert sand as in the sand of the seashore, the mean ratio $\frac{\text{length}}{\text{height}}$ being 17·6 for the blown-sand ripples of the shore, and 18·4 for those of the desert, difference 3·9 per cent. He had succeeded in reproducing these ripples by the action of a steady artificial blast upon ordinary heterogeneous sand, but artificially assorted sand containing no fine particles was not thrown into ripples. For this it was necessary that there should be particles fine enough to be tossed away by the eddy which forms in the lee of the larger grains. Similarly the formation of sand reefs or waves had been observed in the Mississippi when the mixed detritus begins to settle, the finer stuff being churned up from the bottom, and swept away, leaving the coarser materials arranged in ridge and furrow. Sand-dunes were built up by the wind on similar principles. Photographs of desert sand-dunes were shown, one of which exhibited the recent encroachments of sand which have buried the road between Karachi and Clifton. The sand-dunes here are advancing as a train of waves before the south-west monsoon.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A GENTLEMAN who desires to remain anonymous has offered to give 25,000*l.* towards the proposed Birmingham University on condition that a sum of 225,000*l.* is previously subscribed. The amount already promised is 135,000*l.* Under the terms of the gift the 225,000*l.* must be obtained within one year from now.

THE Paris correspondent of the *Chemist and Druggist* states that M. Dabout, doyen of the Paris Faculty of Sciences, and Prof. Lippmann are to represent the Paris University at the jubilee celebrations of Sir George Stokes at Cambridge next June. The Faculty of Medicine and the School of Pharmacy will send delegates to the Congress to be held at Berlin from May 24 to 27, for the purpose of studying the means of combating tuberculosis, especially amongst the lower classes.

ON the recommendation of the Lord-Lieutenant the Queen has approved of the appointment of Prof. Alexander Anderson as president of the Queen's College, Galway, in succession to Mr. W. J. M. Starkie, who has become Commissioner of National Education in Ireland. Prof. Anderson was a student of Galway, and has held for many years the chair of Natural Philosophy in the College, which chair he will retain. He was a high wrangler at Cambridge, a Fellow of Sidney Sussex College, and also a Fellow of the Royal University of Ireland. He is well known for his many contributions to the literature of physics, and for the manner in which he has developed the science school in the Galway College.

AN interesting investigation has just been commenced in the engineering department of the Massachusetts Institute of Technology. The object is to determine the modulus of elasticity or the deflection due to a load applied for a long interval (in this case, a year) in comparison with that due to a suddenly applied load. It appeared from tests made many

years ago at the Institute that the "time" modulus was about one half that for the sudden application. The old tests were all on sticks of moderate size. The new apparatus is capable of taking eight 6 × 12 hard pine beams at one time, and giving a fibre stress of 2500 pounds on each beam. The machine has just been set up with eight beams subjected to a load producing a fibre stress of 2000 pounds. The deflections of each beam are measured with a micrometer. The deflections are measured daily during the early part of the experiment. Record will be kept of these deflections, and of any other change that takes place through the summer and into the next year. Tests will soon be undertaken on the strength of timber as affected by moisture.

IT has been known for some time that increased attention was to be given to the study of geography at Oxford. The announcement is now made that a fully equipped school of geography, or a geographical institute, will shortly be established under the superintendence of the University Reader in Geography, Mr. H. J. Mackinder. The Royal Geographical Society has offered 400*l.* a year for five years towards the maintenance of this school, on condition that the University contribute an equal sum. The delegates of the Common University Fund have agreed to contribute 300*l.* towards the University's share, and early in the Easter term the Curators of the University chest will be asked to add another 100*l.*, and there is every reason to believe that Congregation will approve the decree. The scheme will be under the supervision of a Committee of eight; four, with the addition of the Vice-Chancellor *ex officio*, to represent the University, and three the Royal Geographical Society. The Reader will act as director of the school, and will have an assistant, besides two lecturers who will deal with special aspects of the subject.

THE address delivered by Mr. James Stuart, M.P., on the occasion of his installation as Lord Rector of the University of St. Andrews in January last, has been published by Messrs. Macmillan and Co., Ltd. The argument pursued is of special interest to those who urge that increased attention should be given to science in our Universities: it is summed up as follows: "We are in a period of great change. The Universities should form the connecting link between the past and the future. To do this they must respond to new demands and take up a more extended view of the professions for which they prepare, and of the subjects which they teach. If they do, it will be greatly to the advantage both of them and of the nation." Mr. Stuart acknowledges that engineering has almost won its way into our University system, but even yet the subject is inadequately represented. Engineering and the profession of teaching are two of many callings of mankind which ask for and require University recognition, because their subject-matter has become at last capable of organised and scientific treatment. For the same reasons, trade and commerce should be brought within the pale of the University system. Mr. Stuart not only advocates the inclusion of a larger number of professions within the purview of the Universities, but also a wider extension of the range of subjects for general education.

A COPY of the report of the Technical Education Committee of the Derbyshire County Council, dealing with the work accomplished during the session 1896-7, and with the financial statements for two years, 1896-8, has been received. Though the annual income of the Committee amounts to 10,000*l.*, it is found quite inadequate for the educational work required in the county. The endeavour of the Committee has consequently been rather to supplement than to supersede local effort. The work of the Agricultural Department is mainly carried on in connection with the University College at Nottingham, and the Midland Dairy Institute at Kingston, Notts. The teaching of mining is similarly closely connected with that of the Firth College, Sheffield. In this way, while having due regard to the requirements of the students in their own county, the Committee are helping to extend the usefulness of institutions concerned with higher education. As already mentioned, the Derbyshire Education Committee has been recognised by the Department of Science and Art as being responsible for the science and art instruction in its area, and the steps which the Committee have since taken are duly recorded in the report. There seems to have been a falling off in the number of scholars attending evening continuation, science, art, and technology classes during the session 1897-8. We are glad to notice that the work of developing public secondary schools throughout Derbyshire has received considerable attention, and that proper assistance towards the provision of practical instruction in science in such schools is being given.

DURING the past two years (says the *British Medical Journal*) the University of New Mexico has been carrying on a scientific investigation of the climatology of the Mexican plateau, especially with respect to its beneficial effects in cases of tuberculosis and analogous diseases. Statistical information has been collected, and special studies in the variation in vital capacity among students in the University and the public schools of the territory have been carried on. The biological and bacteriological departments, under the special direction of President Herrick and Prof. Weinzirl, have taken up the study of air and water and the conditions of sepsis, &c. It has been hoped to extend this investigation to include the physical and chemical characteristics of the climate, and also a study of the blood changes due to altitude, with special reference to the virulence and curtailment of the diseases in question. Not long ago Mrs. Walter C. Hadley made to the University a proposal to give the sum of 10,000 dollars to be used towards the erection of a building to contain the laboratories for these and allied researches. The gift is made conditional upon the authorities raising a further sum of 5000 dollars for the completion of the building and a similar sum for equipment. The Regents have agreed to establish the chair necessary to continue and prosecute the research, and have undertaken to do their best to obtain the supplemental moneys required by the terms of Mrs. Hadley's donation.

APPRECIATIVE reference has frequently been made in these columns to the munificent gifts made by Sir W. C. McDonald to the McGill University, Montreal. A Toronto correspondent of the *Times* gives, in yesterday's issue, an account of these and other benefactions, and expresses the hope that they will inspire the friends of science in England to do for Cambridge what generous benefactors have done for the McGill University. The new chemistry and mining department of the University, opened in December, is the last of a series of three magnificent structures built, equipped from top to bottom, and endowed by Sir W. C. McDonald. The first is devoted to physics; the second to engineering; the third to chemistry and mining. All these buildings have been constructed within the last five years. The engineering building cost 400,000 dollars, to which an endowment of 85,000 dollars for maintenance has been added. On the physics building 250,000 dollars have been expended, and the maintenance fund is 150,000 dollars. For the chemistry and mining buildings 425,000 dollars were at first given for construction and maintenance, but a further sum of 180,000 dollars has, since the beginning of the new year, been added to place the endowment on a thoroughly secure basis, thus making in all more than half a million dollars which have been spent upon this department alone. In the construction and equipment of the building, the donor gave absolute *carte blanche* to the architects and the men of science to whom was entrusted the work of carrying out the designs, and they were therefore free to ransack like institutions throughout the world to find everything that was best in the way of outfit and equipment. From top to bottom everything seems complete, and the best that money can buy, the result being that, so far as the departments referred to are concerned, McGill University is now as perfectly equipped as any institution in the world.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, March.—Extremes of temperature in London and its neighbourhood for 104 years. This is a very useful little table for reference, showing the monthly absolute maxima and minima temperatures observed at the apartments of the Royal Society (Somerset House) from 1794–1843; at the Royal Observatory, Greenwich, from 1841–1890; and at Camden Square, from 1858–1897. During this long series, the absolute maximum is 97°·1, at Greenwich, in July 1881, and the absolute minimum 4°·0, at Somerset House, in December 1796, and at Greenwich, in January 1841. This table also shows that the reading of 64°·8, recorded at Camden Square on February 10 last (to which we recently referred), was more than 2° higher than any temperature in February in the neighbourhood of London since 1794.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 9.—"On the Structure and Affinities of *Matonia pectinata*, R. Br., with an Account of the Geological History of the Matonineæ." By A. C. Seward, F.R.S., University Lecturer in Botany, Cambridge.

The genus *Matonia* has long been known as an isolated type among existing ferns. It is represented by two species, *M. pectinata* R. Brown and *M. sarmentosa* Baker, both confined to the Malayan region. Matonia has not hitherto been examined anatomically, and its reference by several writers to an intermediate position between the Cyatheaceæ and Gleicheniaceæ, is based on the structure of the sorus, which, in the small numbers of sporangia and in its circular form, resembles the latter family, while the presence of an indusium and the position of the annulus afford connecting links with Cyatheaceous ferns.

In *Matonia pectinata* the frond has a characteristic pedate habit, with numerous long pinnæ having slightly falcate linear segments, practically all of which appear to be fertile. The sori are circular in form and indusiate, consisting of about eight large sporangia with an oblique incomplete annulus. The dichotomously branched rhizome, which grows on the surface of the ground, is thickly covered with a felt of multicellular hairs, and gives rise to long-stalked fronds from its upper face, and a few wiry roots, which may arise from any part of the surface of the stem.

The material which rendered possible the investigation of the anatomical structure was generously supplied by Mr. Shelford, of the Sarawak Museum, Borneo.

The stem is polystelic, and of the gamostelic type; there may be two annular steles, with the centre of the stem occupied by ground-tissue, or in shorter branches of the rhizome a third vascular strand may occupy the axial region. Each stele consists of xylem tracheids and associated parenchyma, surrounded by phloem composed of large sieve-tubes, with numerous sieve-plates on the lateral walls, and phloem parenchyma; an endodermis and pericycle surround each stele, and in the case of the annular steles these layers occur both internally and externally. At the nodes the outer annular stele bends up into the leaf-stalk, and a branch is given off also from the margin of a gap formed in the inner annular stele; the axial vascular strand may or may not be in continuity with the meristele of the leaf. The petiole is traversed by a single stele, similar in shape to that of certain Cyatheaceous ferns.

The most interesting feature in the structure of the pinnules is the marked papillose form of the lower epidermal cells. The roots have a triarch stele enclosed by a few layers of thick brown sclerous cells.

In structure *Matonia pectinata* presents points of agreement with several families of ferns, on the whole approximating more closely to the Cyatheaceæ than to any other family; but the peculiarities are such as to fully confirm the conclusion previously drawn from external characters that Matonia should be placed in a separate division of the Filices.

In Matonia we have a survival of a family of ferns, now confined to a few localities in Borneo and the Malay peninsula, and represented by two living species, which in the Mezozoic epoch had a wide geographical rage, being especially abundant in the European area.

"New Form of Light Mirrors." By A. Mallock. Communicated by Lord Rayleigh.

The author in this paper describes a new form of light mirror, which he thinks may be useful in cases where extreme lightness and good definition have to be combined.

The mirrors are formed by stretching the thin films left on the surface of water, after a few drops of a solution of pyroxyline in amyl acetate have been allowed to spread there and evaporate, over rings whose edges have been ground to a true plane.

The contraction of the film in drying causes it to approach so closely to the plane in which the edge of the ring lies, that when used as a reflector, the definition is equal to that obtained from a worked glass surface of the same area, at any rate until the film is more than two and a half inches in diameter.

A two-inch diameter mirror may be made weighing considerably less than ten grains.

The author found considerable trouble, not yet completely overcome, in silvering the films; but success in this matter appears to depend entirely on securing extreme surface cleanliness both of the films and silvering bath, the films being in this respect enormously more sensitive to surface tension influences han glass.

"On the Gastric Gland of Mollusca and Decapod Crustacea: its Structure and Functions." By C. A. MacMunn, M.A., M.D. Communicated by Dr M. Foster, Sec. R.S.

In 1883 the author communicated a paper to the Royal Society in which he described a pigment occurring in the so-called liver of Invertebrates, which from its resemblance to plant chlorophyll he named entero-chlorophyll, and in the *Philosophical Transactions* (Part i., 1886), a further contribution was published.

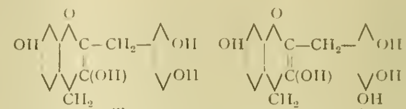
In the present paper the histology of the gland is dealt with, and additional observations made by means of the spectrophotometer, and otherwise, are described.

Great difficulties attend the preparation of the gland for microscopical purposes; the author has, however, succeeded in getting very satisfactory sections by means of formol—20 to 30 per cent.—followed by 95 per cent. alcohol, and embedding in celloidin. The sections being stained by hæmalum, eosin, mucicarmine, thionin, "Soudan III.," &c. Curves obtained by means of the spectrophotometer show that entero-chlorophyll and plant chlorophyll are not identical, but when the latter is changed into the well-known "modified" form, the maxima and minima correspond. From this and other data it appears that entero-chlorophyll is food chlorophyll which has been acted on by the digestive juices. A study of sections confirms this view, as one can see the entero-chlorophyll actually within the intestinal epithelium of *Patella*, *Mytilus*, &c., *dissolved in a fatty medium*, and between these epithelial cells, leucocytes, which carry it to the gastric gland and elsewhere, are seen insinuating themselves. In addition to its other functions, the gastric gland appears to be an organ of excretion.

Physical Society, March 24.—Prof. Oliver Lodge, F.R.S., President, in the chair.—Mr. W. R Cooper read a paper by Mr. A. P. Trotter on the minor variations of the Clark cell. The author describes a series of experiments in which he compared the E.M.F. of certain standard cells at frequent intervals from July 1896 to February 1897, at Cape Town, where the temperature of the double box containing the cells varied between the limits 13° C. and 28° C. One cell was selected for comparison with all the others. No special precautions seem to have been taken to keep the temperature of this selected cell constant. The observed differences between the E.M.F. of the respective cells rarely exceeded 0·001, corresponding to about a quarter of an inch on the slide-wire of the potentiometer. Details as to the area of the slider-contact are not stated; the readings were generally taken to the fourth decimal, *i.e.* to one-tenth of a millivolt, and occasionally to one-fourth of this. Temperature was read to 0·1° C. on a mercury thermometer placed through a hole in the double box containing the cells—not in the cells themselves. Mr. E. H. Griffiths said that the paper appeared to have value only in so far as it showed that Clark cells at Cape Town behaved in a manner that agreed with common knowledge and general experience everywhere else. Their variations depended upon shifts of temperature, and the consequent changes in the degree of saturation of the liquid. From his own experiments during seven years, upon forty-two Clark cells, he had shown that if temperature was kept constant to within 0°·01 C., the steadiness and uniformity of all the E.M.F.s was most remarkable. They started with discrepancies, but at the end of the time it was impossible to detect any differences. It was of little use to put a thermometer anywhere but within the cells; very slight changes of temperature caused serious changes in the degree of saturation of the liquid. The existence of the capricious lag of E.M.F. behind temperature precluded the possibility of formulating a temperature correction for Clark cells. In the case of Callendar cells there was no lag; their E.M.F. varied slightly with temperature, by a definite amount, which could be corrected by a coefficient. Mr. W. R. Cooper said the method of comparison used by the author was unsuitable, because to arrive at the differences of E.M.F. necessitated the measurement of the E.M.F. of each cell. The variations only amounted to a few ten-thousandths of a volt. The length of potentiometer-wire corresponding to a thousandth of a volt was only a quarter of an inch; under such conditions it would be difficult to ensure accuracy. A method of opposition would have been preferable. Mr. Cooper had found that Board of Trade cells only vary about

one ten-thousandth of a volt between themselves from day to day. Cells of the H-form vary about one-fifth of that amount.—Prof. J. D. Everett then read a paper by Dr. E. H. Barton and Mr. W. B. Morton, on the criterion for the oscillatory discharge of a condenser. The object of the paper is to inquire how the condition for the oscillatory discharge of a condenser is modified when the ordinary differential equation of the second degree is supplemented by the terms added by Maxwell to take account of the distribution of current in the (straight) wire. The coefficients of these terms are relatively small, so that the algebraic equation giving the periods is a quadratic with small terms of higher order added. The effect of these higher terms is, first, to introduce very rapid vibrations of small amplitude; and, next, to displace the roots of the unaltered quadratic. The nature of the discharge—oscillatory, or non-oscillatory—may be taken to be determined by these principal roots, and the critical case is when they are equal. The condition for equality is obtained, by the property of the derived function, as a series of powers of the small coefficients of the equation, which may be carried by successive approximation as far as is desired. The paper also treats the question by an alternative, and more physical, method, which consists in replacing the resistance, inductance, and capacity that occur in the ordinary formula, by modified values. This gives the criterion correct to the third order in the small terms. It is shown that a condenser satisfying the critical condition on the simple formula would, when the added terms are taken into account, give an oscillatory discharge. Prof. Lodge said that the result naturally to be expected of "throttling," viz. the increase of resistance, and decrease of self-induction, due to the current keeping to the outside of the conductor, would tend rather to damp out the oscillations than to favour them. Prof. Everett observed that the equation was no longer a quadratic, and that the quadratic criterion as to whether the discharge was oscillatory or non-oscillatory, did not hold. The paper appeared to be consistent with itself, and he considered that the authors had satisfactorily proved, in their discussion of the equation of current, that the effect of "throttling" was to increase the tendency towards the oscillatory mode of discharge. Prof. Lodge admitted that the quadratic criterion did not hold; he thought it most likely that the authors, who evidently had gone into the matter with care, were right. At the same time he wished to call attention to the singular and unexpected character of their conclusion. If it turned out that it was correct, *i.e.* that there was no slip in sign, it was a result upon which he would desire to congratulate them. The President proposed votes of thanks, and the meeting adjourned until April 21.

Chemical Society, March 16.—Prof. Dewar, President, in the chair.—After the presentation of a daguerreotype of Dalton to the Society by the President, the following papers were read:—The boiling point of liquid hydrogen as determined by a rhodium-platinum resistance thermometer, by J. Dewar. After successfully overcoming the experimental difficulties, the author has prepared considerable quantities of colourless liquid hydrogen for the purpose of determining its boiling point. A pure platinum resistance thermometer gave the boiling point as 35° absolute, whilst a rhodium-platinum resistance thermometer gave the boiling point as 27 absolute; by the use of a constant volume hydrogen thermometer working under reduced pressure the boiling-point of liquid hydrogen was found to be 20° absolute.—Influence of substitution on specific rotation in the bornylamine series, by M. O. Forster. The author has prepared and examined methylbornylamine, dimethylbornylamine, ethylbornylamine, diethylbornylamine, *n*- and iso propylbornylamine, butylbornylamine, benzylbornylamine, and ortho- and para-nitrobenzylbornylamine in order to determine the influence of substitution upon the specific and molecular rotations of bornylamine.—Contribution to the characterisation of racemic compounds, by A. Ladenburg. The author amends his definition of racemism in the light of the experiments of Kipping and Pope.—Rotatory powers of optically active methoxy- and ethoxy-propionic acids prepared from active lactic acid, by T. Purdie and J. C. Irvine. Methylic methoxypropionate and ethylic ethoxypropionate, prepared from the lævo-lactates by the action of alkyl iodides and silver oxide, have the specific rotations −95·53° and −79·69° respectively; this confirms the previous conclusion that the high activity of the alkyl lactates made from the silver salt is due to the presence of alkyloxypropionates.—On brasilin and hæmatoxylin (II.), by A. W. Gilbody and W. H. Perkin, jun. From a study of the oxidation products of dimethylbrasilin, the authors conclude that brasilin and hæmatoxylin have the following constitutions:—



Brasilin. Hæmatoxylin.

—Crystallisation of dynamic isomerides. A correction, by T. M. Lowry.

Geological Society, March 8.—W. Whitaker, F.R.S., President, in the chair.—An analysis of the genus *Micraster*, as determined by rigid zonal collecting, from the zone of *Rhynchonella Cuvieri* to that of *Micraster cor-anguinum*, by Dr. A. W. Rowe. The author has endeavoured to show, by means of rigid zonal collecting on a large scale, from the white chalk of the southern and south-eastern coast-sections of England, that the genus *Micraster* is one and the same form gradually evolving from the more simple to the more complex. In doing this, he also contends that the genus may be divided into definite groups, each or several of which are absolutely diagnostic of the various chalk zones, as defined by Barrois. The conclusions arrived at point to the regular and continuous deposition of the white chalk, and strikingly confirm the general accuracy of Barrois's zoning. The paper gives a minute comparison and description of the genus *Micraster* from a general point of view, and from that of a group, and deals particularly with the essential details of the test of the especial groups characteristic of each zone. The author claims that, so far as *Micraster* is concerned, each zone is marked by a definite facies of essential characters of the test, which are purely horizontal, and that all species and varieties, however divergent they may apparently be, occurring at any given horizon, are stamped with the impress of these marked horizontal features. The author proves that, while in an isolated instance, one may be unable to decide the horizon in the white chalk whence a specimen of *Micraster* was derived, in the ninety-nine other cases the diagnostic features described by him point unerringly to the exact horizon, and thus afford a valuable aid to stratigraphical geology, especially as the essential zonal features of the test are easily made out in the field.—On a sill and faulted inlier in Tideswell Dale (Derbyshire), by H. H. Arnold-Bemrose. The compact dolerite in the marble-quarry in Tideswell Dale has been generally described as a lava; but Sir A. Geikie, in his "Ancient Volcanoes of Great Britain," suggested the possibility that it might be a sill. In the present paper the author endeavours to prove that the rock is really a sill.

Entomological Society, March 15.—Mr. G. H. Verrall, President, in the chair.—Mr. Tutt exhibited a very fine series of *Epunda lutulenta* captured by the Rev. C. R. N. Burrows last autumn near Mucking in Essex. This series, while agreeing in the main with Borkhausen's typical form, varied *inter se* in such a manner as to give almost parallel forms to those so well known from Scotland and Ireland, yet they had the ordinary blackish-fuscous ground colour, and not the intense black peculiar to the latter. Mr. Merrifield showed some Lepidoptera collected in the latter half of May and the first week of June, near Axolo (Venetia), Riva, and Bozen. They included some very fine specimens of *Syrichthus carthami*, a very large *Syntomis phegea*, and examples of *Pararge egeria* intermediate in colour between the Northern and Southern European forms. Mr. G. T. Porritt exhibited a series of extreme forms of *Arctia lubricipeda*, var. *fasciata*, and also some examples of what appeared to be a new form of the species. Mr. O. E Janson exhibited an inflorescence of *Araujia albens*, Don., together with a butterfly which had been entrapped by getting its proboscis jammed in one of the flowers. It was found at Monte Video.

Royal Microscopical Society, March 15.—Mr. E. M. Nelson, President, in the chair.—The President called attention to a fine example of Wilson's screw-barrel microscope which had been presented by the Treasurer. The instrument was probably 150 years old, and would be a valuable addition to the Society's collection.—The President then said Mr. Curties had sent for exhibition an old microscope made by Chevalier, *circa*

1840; it was an early example of microscopes made after the introduction of achromatism.—Mr. Rousselet exhibited and described a mounted specimen of a rare rotiferon, *Trochosphaera solstitialis*, first found by Staff-Surgeon Gunson Thorpe in China. It had since been found in America, and the specimen now exhibited was probably the first seen in this country. The first species of this genus discovered *T. aequatorialis*, was found in the Philippine Islands by Prof. Semper, who described it in 1872.—Mr. Lewis Wright then gave an exhibition of microscope slides by means of his improved projection microscope, and demonstrated the progress made since he gave his previous exhibition before the Society fourteen and a half years ago. Several improvements had been made in the interval: in the condensers it had been found better to use four lenses, by which spherical aberration was practically abolished. He had also learned from the President the necessity for adjusting the cone of light to the aperture of the objective. The fine adjustment had been improved, and great advances had been made in objectives. An important improvement had been made in the screen, which was covered with a thin coating of silver, by which the brilliancy of the pictures was greatly increased. It was found that with a plain silvered surface the image could only be seen by persons in front of the screen; but by having the surface minutely striated vertically, persons seated at the sides could see quite well.—Dr. Hebb said another paper had been received from Mr. Millett, being Part v. of his report on the Foraminifera of the Malay Archipelago, which, on account of its technical character, he proposed should be taken as read. —It was announced that at the next meeting a paper would be read by Dr. Lionel S. Beale, on "The bioplasm of man and the higher animals, and its influence in tissue formation, action and metabolism—a microscopical study."

Zoological Society, March 21.—Dr. W. T. Blanford, F.R.S., Vice-President, in the chair.—Mr. E. T. Newton, F.R.S., exhibited and made remarks upon some fossil remains of a Mouse from Ightham, Kent. He pointed out that the name under which he had described the specimens in 1894, viz. *Mus abbotti*, had been previously employed by Waterhouse for a Mouse from Trebizond, and that he proposed to substitute *Mus lewisi* for that name. A communication was read from Dr. G. Stewardson Brady, containing an account of the Copepoda collected, chiefly by means of the surface-net, by Mr. G. M. Thomson, of Dunedin, and by Mr. H. Suter, on behalf of the Zoological Museum of Copenhagen. It was shown that several species were identical with well-known European forms, and others were closely allied, but many were entirely distinct and presented very interesting peculiarities.—Mr. W. P. Pycraft gave an account of the osteology of the Tubinares. He pointed out the Stork-like character of the group, which had not been before emphasised, so far as regards osteological features.—Mr. F. E. Blaauw gave an account of the breeding of the Weka Rail (*Ocydromus australis*) and Snow-Goose (*Chen hyperboreus*) in his park at Gooilust, North Holland. The Rails could not, on several occasions, be induced to complete the periods of incubation, always eating the eggs after sitting for a few days. One young one was eventually hatched by placing an egg under a Bantam-hen. The Snow-Goose (a female) paired with a male Cassin's Snow-Goose (*Chen caerulescens*), and laid and hatched three eggs. The young birds, it was stated, were apparently assuming the plumage of the male parent.—Mr. W. E. de Winton read a paper on two species of Hares from British East Africa, specimens of which had been collected by Mr. Richard Crawshay. One of them, from the plains of the Upper Attie, was referred to *Lepus somalensis*, Heugl., a species which had not previously been recorded south of Somaliland. The other species from Kitwi, a short-eared form, which somewhat resembled the Nyasaland Hare (*L. whytii*), but differed in its black-tipped fur and also in its dentition, was named *L. crawshayi*, sp. nov. —A communication was read from Dr. A. G. Butler, containing an account of the Butterflies collected by Mr. Crawshay in British East Africa in 1898. Specimens of 62 species (which were enumerated in the paper) were contained in the collections, three of which were made the types of new species, viz. *Acraea astrigera*, *Scolitantides crawshayi*, and *Pyrgus machacosa*.

CAMBRIDGE.

Philosophical Society, March 6.—Mr. J. Larmor, President, in the chair.—Notes on the Binney collection of Carboniferous plants. I. Lepidophloios, by A. C. Seward. In 1872 Binney described some unusually perfect sections, prepared from stems found in the clay-iron-stone of the Coal-Measures near Dudley, which he referred to two species, *Lepidodendron Harcourtii* Witham and *Halonia regularis* Lind. and Hutt. The specimens now form part of the Binney collection in the Woodwardian Museum. All the sections (four in number) must undoubtedly be referred to the same species, and most probably to *Lepidophloios fulginosus* Will.—A note on the way in which bones break, by Dr. Joseph Griffiths. After describing the construction of the shaft of a long bone and pointing out that bone in the adult is hard and tough but not brittle, Dr. Griffiths showed that the long bones are adapted to resist pressure when applied from end to end, that is, in their length. He then demonstrated by means of specimens of bones he had experimentally fractured, the way in which they break on the application of a bending force, of a direct blow and of a blow on the free extremity when a portion of the other end was fixed.—On the origin of magneto-optic rotation, by J. Larmor. The object of this note is to point out that it is possible to deduce the Faraday effect from the Zeeman effect by general reasoning as regards any medium in which the optical dispersion is mainly controlled by a series of absorption bands for which the Zeeman effect obeys the above law, without its being necessary to introduce any special dynamical hypothesis. For this law ensures that the effect of the magnetic field on the periods of the corresponding free vibrations of the molecules is the same as that of a bodily rotation, say with angular velocity ω, round its axis: while the complete circular polarisations of the Zeeman doublets, viewed in the direction of the axis, show that their states of vibration are symmetrical with respect to that axis.

EDINBURGH.

Royal Society, March 6.—Prof. McKendrick in the chair. —Prof. A. Crichton Mitchell read a paper on the convection of heat (Part i.), in which Newton's law of cooling was discussed. In most of the references to Newton's law, the circumstances under which Newton declared the law to hold are either disregarded altogether or mentioned in the vaguest way. By his own experiments on the cooling of a copper ball in a steady current of air, Prof. Mitchell found that Newton's law of cooling was accurate up to temperature differences of 100° C. in steady currents of air of as much as ten miles per hour. The stronger the current the quicker the cooling; but the discussion of the precise law connecting the two was reserved for a future communication. The results suggested the possibility of a form of anemometer, in which the speed of the wind might be measured by its cooling effect on, for example, a wire heated by a steady electric current.—Dr. Buchan presented a detailed account of the meteorology of Ben Nevis (Part ii.). Such important questions as the differences of temperature and pressure at the base and the summit of Ben Nevis were discussed, and were shown to be intimately connected with the cyclonic or anti-cyclonic conditions existing or approaching. The observed relation between pressure and height had led to an important correction to Laplace's well-known formula. When applied to the reduction to sea-level of observations in Scandinavia and other localities, the Ben Nevis empirical formula brought consistency where, with the use of Laplace's formula, there had been obvious discrepancy. In the discussion of the diurnal barometric variation, it had been found necessary to separate the cloudy and clear days; and this had suggested applying the same method to analyses of the meteorological statistics of other places. It thus appeared that the influence of cloud was to produce an evening maximum, and completely change the form of the daily barometric curve.—Dr. Hugh Marshall, in a note on polarisation phenomena observed in quantitative electrolytic determinations, mentioned that, in the case of certain solutions, the completion of the electrolysis of the metal was shown by a sudden rise in the potential difference of the electrodes. The addition of a small quantity of the metal to the solution produced an immediate fall of this potential difference to its normal value.—Dr. Noël Paton gave an account of a detailed examination of a study by Drs. Dunlop, Macadam, and himself on the influences of diphtheria toxin on the metabolism. The metabolism in simple fasting was compared with the metabolism in fasting with fever in dogs; and among the more important results obtained were these: (1) the increase in fever of the proportion of nitrogen not as urea; (2) the non-increase of the proportion of nitrogen

in ammonia; (3) the increase in the proportion of neutral sulphur, but not in the sulphur as sulphuric acid, thus explaining the non-increase of ammonia and corresponding with diminished elaboration of urea; (4) non-increase in the proportion of phosphorus as phosphates, indicating the absence of an increased decomposition of nuclein compounds; (5) no alteration in the proportion of potassium and sodium, such as has been described by Sachowski as occurring in fever in man; (6) decrease in the excretion of chlorine out of proportion to the decrease in the bases, raising the question of what acids take the place of hydrochloric acid in the urine.—Dr. Gregg Wilson, in a paper on the first foundation of the lung in Ceratodus, showed that the lung arises, as in amphibians and higher forms, in a mid-ventral gut in the pharynx, immediately posterior to the gill region. This expands into a considerable unpaired vesicle, which in later stages grows round the gut till it lies dorsally.—Dr. Gregg Wilson also read a paper on the embryonic excretory organs of Ceratodus, in which the pronephros was shown to be of amphibian type, having two nephrostomes opening directly into the anterior of the body cavity. Later there is a pronephric chamber formed, as in amphibia, by secondary fusion of the gut and body wall. Into this region of the cœlom the glomerulus projects. The backward growth of the union of gut and body wall finally leads to the closing of the nephrostomes and the obliteration of the pronephric chamber.

Paris.

Academy of Sciences, March 20.—M. van Tieghem in the chair.—The President announced to the Academy the death of M. Naudin, Member of the Botanical Section.—Action of hydrogen sulphide and alkaline sulphides upon the double cyanides, by M. Berthelot. This paper contains thermochemical data for the reactions between AgCN.KCN, $Hg(CN)_2 2KCN$, $Zn(CN)_2 2KCN$, and hydrogen or sodium sulphides.—Maximum quantity of chlorides contained in sea air, by M. Armand Gautier. The greatest amount found was 0·022 mgr. of common salt per litre of air.—Astronomical and magnetic observations made on the eastern coast of Madagascar, by M. R. P. Colin.—Observations of the Swift comet (1899 *a*), made at the Toulouse Observatory with the 23 cm. Brunner equatorial, by M. F. Rossard.—Observations of the Swift comet (1899 *a*), made at the Observatory of Besançon by M. P. Chofardet, by M. J. Gruey.—On the lines of curvature of certain surfaces, by M. E. Blutel.—On some applications of the law of parallelism to bundles and congruences, by M. C. Guichard.—On some arithmetical properties of analytical functions, by M. Paul Staeckel.—On the unsymmetrical alternating current arc between metals and carbons, by M. A. Blondel. The oscillations are given in the form of curves, fifteen of which are reproduced in the paper.—On the increase of the mean intensity of the current by the introduction of the primary of the coil, in the case of the Wehnelt electrolytic interrupter, by M. H. Pellat. In a circuit at 110 volts, containing the Wehnelt commutator but not the primary of the coil, an ammeter showed four to five amperes. The introduction of the additional resistances of the primary of the coil increased the current to twenty-five amperes, the additional impedance thus considerably increasing the mean current strength. This paradoxical result is shown to be in accordance with the known laws of induction.—On an isomer of menthoxylic acid, by M. Georges Leser.—On the electro-negative character of certain unsaturated organic radicals, by M. Ernest Charon. The propylenic group, $CH_3.CH=CH$— has much more marked electro-negative properties than the vinyl group, $CH_2=CH$—.—Action of formaldehyde upon albumenoid materials. Transformation of peptones and albumoses, by M. Charles Lepierre.—Silico-tungstic acid as a reagent for alkaloids, by M. Gabriel Bertrand. The reagent proposed is $12WO_3.SiO_2.2H_2O$, or its sodium salt, in 5 per cent. solution. It has the advantages of giving well-defined salts, absolutely stable, the analysis of which can be made with exactitude. Its high molecular weight is also advantageous. The precipitates formed have the composition

$$[12WO_3.SiO_2\ 2H_2O + 4\,\text{alk.} + nH_2O];$$

analyses are given of the salts with pyridine, morphine, and strychnine.—Researches on the physiological value of the pyloric tubes in certain Teleostia, by M. Th. Boudourg.—An old Russian legend relating to a fall of stones, by M. Stanislas Meunier.

Gottingen.

Royal Society of Sciences.—The *Nachrichten* (mathematico physical section) part iv. for 1898, includes the following memoirs communicated to the Society:—

October 29, 1898.—W. Voigt: On the connection between the Zeeman and the Faraday effects.

November 26.—H. Ludendorff: On a remarkable property of certain equations in the theory of characteristic planets.—W. Voigt: Theory of the phenomena observed by Macaluso and Corbino. Double refraction of sodium vapour in the magnetic field at right angles to the lines of force.

DIARY OF SOCIETIES.

WEDNESDAY, April 5.

Entomological Society, at 8.

THURSDAY, April 6.

Linnean Society, at 8.—On *Carex Wahlenbergiana*: C. B. Clarke, F.R.S.—On the Discovery and Development of Rhabdites in Cephalodiscus: F. J. Cole.

FRIDAY, April 7.

Geologists' Association, at 8.—The Geology of Brittany, with Special Reference to the Whitsuntide Excursion: Dr. Charles Barrois.

BOOKS AND SERIALS RECEIVED.

Books.—Die Optischen Instrumente: C. Leiss (Leipzig, Engelmann).—Kritik der Wissenschaftlichen Erkenttnis: Dr. H. v. Schoeler (Leipzig, Engelmann).—Light Railways at Home and Abroad: W. H. Cole (C. Griffin).—A Manual of Locomotive Engineering: W. F. Pettigrew and A. F. Ravenshear (C. Griffin).—Die Kontinuität der Atomverkettung: Dr. G. Hormann (Jena, Fischer).—The New Science and Art of Arithmetic: A. Sonnenschein and H. A. Nesbitt (Sonnenschein).—Le Climat de la Belgique en 1897: A. Lancaster (Bruxelles, Hayez).—Life of Admiral Sir Wm. R. Mends: B. S. Mends (Murray).—True Tales of the Insects: L. N. Badenoch (Chapman).—Explorations in the Far North: F. Russell (Iowa).

Serials.—Economic Journal, March (Macmillan).—Journal of the Royal Horticultural Society, April (Victoria Street).—Journal of the Chemical Society, March (Gurney).—Physical Review, February (Macmillan).—Good Words, April (Isbister).—Sunday Magazine, April (Isbister).—Chambers's Journal, April (Chambers).—L'Anthropologie, tome x. No. 1 (Paris).—Humanitarian, April (Duckworth).—Bulletin of the American Mathematical Society, March (New York).—Science Gossip, April (Strand).—Century Magazine, April (Macmillan).

CONTENTS.

THURSDAY, APRIL 6, 1899.

BIRDS.

Birds. By A. H. Evans, M.A. Being Vol. ix. of the Cambridge Natural History. Pp. xvi + 635. (London: Macmillan and Co., Ltd., 1899.)

IN getting together the material for this exceedingly elaborate treatise upon birds, Mr. Evans has shown an industry and discrimination which must at once be obvious to those who have any acquaintance with the enormous literature of the group. When one thinks of the many long handbooks upon British birds only, and the extensive series of large monographs upon special families, it is really a matter for wonder how the author can have condensed into rather less than 600 pages an account of the external characters of so huge a number of existing and extinct genera and species. Mr. Evans has accomplished this difficult task by compressing into as few words as possible the salient characters, or, in many cases, character, of the genus or species, and by a rigid economy in the matter of anatomical and "bionomical" fact. This is not mentioned by way of an introduction to a criticism of the method adopted by the author. It is obviously desirable that the volumes of the Cambridge Natural History should preserve an approximate equality in size; while to give two volumes to birds—which would be necessary were their structure treated of as exhaustively as are the external features—would destroy the perspective of the series. Besides, as Mr. Evans mentions in his preface, several works, such as Dr. Gadow's contribution to Bronn's "Thierreichs," Fürbringer's colossal work, the anatomical sections in Prof. Newton's "Dictionary of Birds," and more recently still Mr. Beddard's "Structure and Classification of Birds," have rendered it less incumbent upon the author to deal more fully with this branch of ornithology. These considerations have clearly made it difficult for Mr. Evans to decide how much anatomy he should include in his work.

Only twenty-two pages are devoted to structure, geographical distribution, classification, and migration. It is unnecessary to point out that to deal with all these important matters, even in the briefest fashion, twenty-two pages is not quite adequate. It would have been better, perhaps, to have allowed the characters of the feathers and pterylosis, beak and claw, and colour and moult, to have absorbed more of this limited space, and to have slightly expanded the "terminology," with, perhaps, an explanatory diagram of the skeleton and of the viscera. In the part relating to feathers and external characters generally, that much discussed matter, "Quintocubitalism," is not even favoured with a mention, let alone a definition. It is unnecessary to point out that many other facts of importance in classification share the same neglect.

As to this latter department, Mr. Evans follows Dr. Gadow's scheme, for which we have a very considerable respect. But it really does not matter greatly in a book of this kind which of the more reasonable schemes is selected. "Quot homines tot sententiæ" (with a very distinct accent on the last word) is a maxim which might have been created for the science of ornithology. The schemes afloat are so very numerous, and so frequently based not upon anatomical fact but upon opinion. The only consolatory thought is that one of them must be right—so complex are the varied combinations and permutations.

As to the smaller details of classification, we are not always in accord with Mr. Evans. He places the African "Shoe bill," *Balaeniceps*, definitely with the herons, in the very same family Ardeidæ. The bird has not, it is true, been studied anatomically in anything like an exhaustive fashion; but enough is known, in our opinion, to militate against this placing of it. Indeed, in his prefatory sketch of the characters of the Ardeæ, the author admits that the bird "might well stand alone in a sub-family" opposed to other herons, or that it might even be handed over to the storks. This opinion is, however, abandoned when the actual bird comes to be treated of—a course of action which shows a somewhat unnecessary vacillation. Some ornithologists also would deprecate the isolation of the flamingo, and would definitely term it a stork. But it is not possible to be dogmatic upon the point. In the arrangement of the cuckoos among themselves, Mr. Evans follows Captain Shelley's British Museum Catalogue of the group. It does not appear to us to be requisite to allow so many as six sub-families; but with the exception of the Neomophinæ, concerning the merits of which defective anatomical knowledge does not permit of an opinion, the sub-families do represent grades of structural diversity. This, however, is only the case if we refer to each the genera which cluster round that particular genus from which the sub-family takes its name. To place among the Cuculinæ, typified by the common cuckoo of this country, the eastern *Eudynamis* and *Scythrops* is a very serious offence against the teachings of anatomy. It is to *Phoenicophäes* that the two genera in question are plainly most nearly allied. The matter is of further importance on account of Prof. Fürbringer's extremely reasonable suggestion that these three genera stand near to the base of the cuckoo tribe; a view supported—it should be added—by the former existence (as shown by fossil remains) of the genus *Phoenicophäes* in Europe.

While Mr. Evans has been unnecessarily liberal in his sub-divisions of the Cuculidæ, he has hardly done justice to the structural diversity that exists among the auks. If it was necessary to divide the cuckoos at all—and we are fully in accord with the author in so doing—it is at least equally advantageous to sub-divide the not more homogeneous family of the Alcidæ. The genera *Lunda* and *Fratercula* are connected by closer bonds than either is with *Uria* and *Alca*, while the two latter form an alliance which is equally patent to the anatomist.

It has been hinted that Mr. Evans is somewhat sparing of anatomical fact in this volume. At the same time he by no means ignores in places anatomical characters. For the most part we find that these characters are quite accurately described. But here and there is a slip. For instance, the Anseriformes are defined by the possession of two pairs of sterno-tracheal muscles, "a marked point of distinction from other Carinate birds." It is unquestionably true that this is a characteristic feature of the large group of ducks, geese, swans, and

screamers; but they are not the only birds which possess this double allowance of extrinsic tracheal muscles. Among the Gallinaceous birds, which present in other points of structure such unexpected likenesses to the Anseres, the same arrangement of the muscles is met with. And the list of birds with two pairs of extrinsic tracheal muscles is not exhausted by the facts mentioned. The number of rectrices in the owls is not invariably twelve, as seems to be implied by Mr. Evans. It is certainly usually so, but one genus is said to possess only ten. This criticism may be fairly regarded as rather pedantic; not so, however, our objection to Mr. Evans' statement that in the owls "the syrinx is bronchial." There is no qualification of this bare sentence, which is only partially true. Many owls, it is well known, do show a purely bronchial syrinx—an interesting likeness to the goat-suckers; but in others the normal tracheo-bronchial syrinx is evident.

At intervals among the exceedingly conscientious descriptions of colour and plumage are to be discovered a few notes upon the customs and habits of the bird tribe. Mr. Evans is particularly emphatic upon the varied sounds and songs—an exceedingly useful part of the subject to lay stress upon. But the tyro, who is probably often puzzled by the notes of a strange bird, will be baffled by the variety of utterances which are described as occasionally pertaining to the same species. One species, for instance, is credited with so great a variety of noises that they can only be expressed by "a bray, a croak, a harsh cackle, a diabolical scream, a puppy's whine, or a soft whistle." "The voice of the goatsucker' is generally hollow, but is described in various cases as a "croak," a "loud shrill cry," a "sad whistle," a "jarring note," or a "moan." We presume that under these extraordinarily diverse tones more than one species is included, though it is not quite apparent from the text. The croaking of the goatsucker reminds us of a slight error in Prof. Newton's "Dictionary of Birds." The professor, under the heading "Night Raven," observes that it is "a bird frequently met with in fiction, but apparently nowhere else." Now it is quite curious that this word immediately follows "Nightjar" in the work referred to—curious because John Hunter, under the heading "Night-Raven," described the anatomy of the nightjar or goatsucker.

Under what may be termed "bionomics," Mr. Evans has some remarks upon mimicry, not condensed into a chapter or section, but scattered through the body of the work. These remarks are not numerous, only four instances being given, or at least noted, in the index. They are entirely among Passerines, and do not include, to our mind, the most striking examples of superficial likeness between birds remote from each other in the system. One of the very best instances is the likeness between the large ground cuckoo *Carpococcyx* and a gallinaceous bird. The cuckoo suggests a pheasant, in its size chiefly and gallinaceous strut, but the colours are not at variance with the view that it represents a genuine case of selective variation in the direction of a gallinaceous model; and it will be remembered that in the birds which the cuckoo suggests there are formidable spurs, which seem to form an excuse for the attempt at protection. But Mr. Evans is unnecessarily redundant when he speaks of this singular phenomenon as "unconscious mimicry"; no one could seriously urge a conscious attempt to put on the appearance of some other bird. But such instances do not form the strongest argument that the believer in mimicry has at his disposal. The advantage is not plain in most cases, and the question of genetic alliance, and therefore genuine likeness based upon affinity, is not to be settled at once. Prof. Garrod, it will be remembered, thought the cuckoos to be not far from the Gallinæ, and there is much to be said for his view.

Such general questions as migration are not neglected by the author. But he has not found space to treat of the matter in a comprehensive way. It may be that more has been written upon this subject elsewhere than it will quite bear; but Mr. Evans has erred—if he has erred—upon the absolutely opposite side. The astounding statements of Herr Gätke upon the prodigious velocity of the migration flight are, we are relieved to find, not accepted; in this matter Mr. Evans might well have quoted Mr. Whitlock's interesting criticisms of Dr. Gätke's calculations. The remarkable way in which individual birds are believed to return to the immediate neighbourhood whence they set forth, is strikingly illustrated by an instance which we have recently seen quoted, though the event itself happened in the year 1834. A gentleman resident in Poland captured a stork and fixed a collar round its neck made of iron, and inscribed "Haec ciconia ex Polonia." The following year the bird returned to his estate, but this time with a golden collar bearing the inscription, "India cum donis mittit ciconia polis." We can answer for the accuracy of the quotation, though the grammar seems to have suffered on behalf of the scansion.

The concluding remark which we have to offer about Mr. Evans' book can contain nothing but praise. The illustrations are most admirable, which indeed might be expected from their author, Mr. G. E. Lodge. The majority, at any rate, are by that well-known draughtsman; some few are from other sources. F. E. B.

A LADY'S DIGGINGS IN EGYPT.

The Temple of Mut in Asher: an Account of the Excavation of the Temple and of the Religious Representations and Objects found therein, as illustrating the History of Egypt and the main Religious Ideas of the Egyptians. By Margaret Benson and Janet Gourlay; the inscriptions and translations by Percy E. Newberry. Pp. xvi + 391. (London: John Murray, 1899.)

THE Egyptian goddess Mut was the wife of the god Amen-Ra and the second member of the great Theban triad of deities, which consisted of herself, her spouse Amen-Ra and her son Chonsu, the god of the Moon. She symbolised nature and was regarded as the mother of all things, as indeed her name *Mut*, "the mother," implies. Her temple at Karnak, situated in a district termed *Asher* by the ancient Egyptians, stood to the south-west of the great temple of Amen-Ra, to which it was connected by a long avenue of sphinxes. A little to the north-west stands the temple of Chonsu, her son, from which another avenue of sphinxes led to Luxor.

Her temple is thus, with the exception of a small temple of Rameses III., the southernmost of those that form the Karnak group. Although in consequence of its ruined condition it, perhaps, receives little attention from the passing tourist, its importance has long been recognised, and it has been frequently studied and described. As Mariette pointed out, although its structure has suffered more than that of others at Karnak, its interest is considerable; for we have in it an entire temple, with its surrounding wall, its pylons, sphinxes and sanctuary, and its sacred lake, which encloses the temple on the south in the form of a great horse-shoe.

Towards the middle of the present century the condition of the temple was probably very much more perfect than it is at present, for about the year 1840 it appears to have been used, with Mohammed Ali's permission, as a stone-quarry during the erection of a saltpetre manufactory in the neighbourhood. The British Museum possesses two manuscript maps of the temple by Burton and Hay, which were probably made between 1830 and 1840; and as Burton's evidently belongs to the period before the saltpetre factory was built, its value as evidence of the former condition of the temple is great. At this period the walls may have stood several feet above the ground, so that the ground-plan of the temple could be traced without difficulty. After they had been levelled, the plan of the temple could only be made out by removing the débris from the bases of columns and the foundations of walls that still remained.

Neither of the plans of the temple made by Burton and Hay was published, and the first published plan is that of Lepsius, made during the Prussian Survey in the years 1842–45. In 1869 Duemichen published a copy of part of the inscription of the time of Tirhakah from the walls of a small chamber in the temple, and in June 1872 de Rougé read a paper before the Academie des inscriptions, in which he translated passages from the inscription Duemichen had published. Since Lepsius' survey, however, no detailed examination of the temple was undertaken until Mariette partly excavated the site, and in 1875 published in his "Karnak" the results of his excavation in the form of the plan which has been regarded as the authoritative plan of the temple up to the present time. Mariette also published a fuller copy of the inscription from the chamber of Tirhakah, which was again republished in 1890 by M. Urbain Bouriant, together with another mutilated inscription from the western wall of the temple. In 1891–93 Sir Norman Lockyer spent three seasons in Egypt studying the orientation of the principal Egyptian temples, among which he included the temple of Mut; as the result of his investigations, he provisionally assigned the date of its foundation to about B.C. 3500.

Such is a brief sketch of the principal surveys and studies of the temple and its inscriptions that had been made up to the time Miss Benson began her work on the site. After a visit to Egypt in 1894, Miss Benson tells us she first entertained the idea of undertaking some excavation, and in the following year she obtained permission to clear away some of the earth that still covered the ruins of the temple of Mut. For three seasons Miss Benson and her friend, Miss Gourlay, have occupied themselves in removing débris, and, though they have made no very startling discoveries, they have succeeded in correcting Mariette's plan of the temple in several details, and in the course of their work have found a number of inscribed statues and fragments.

The first year of excavation was devoted to the outer court of the temple, and did not yield many finds, the most important being a statue of a royal scribe with the cartouche of Ȧmenḥetep II.; and as this was found apparently *in situ*, it served to throw back the date of the temple's foundation, which Mariette had assigned to Ȧmenḥetep III. During the next two seasons the colonnaded court, the hypostyle hall, and the chambers built around the sanctuary of the goddess were cleared. Mariette, in his plan, though in the main correct, had indicated that these chambers were arranged symmetrically; but Miss Benson, by a more complete clearing of the foundations, has shown that such a symmetrical arrangement was not strictly adhered to. It was to be hoped that her excavation would have rendered it possible to assign dates to the various portions of the temple, and this has been done for several portions that were left uncertain by Mariette; unfortunately, however, sufficient evidence has not been found for dating considerable parts of the structure. In his "Dawn of Astronomy" Sir Norman Lockyer has emphasised the importance of ascertaining such dates where possible, for subsequent additions to a temple may considerably interfere with the original design of its orientation. The fresh data obtained by Miss Benson, however, so far as they go, are in favour of the early period assigned to the foundation of the temple by Sir Norman Lockyer.

Of the finds made by Miss Benson in the course of her excavation, the seven fragments of inscribed stelæ and the inscriptions on the Sekhet statues are unimportant. Of the thirty-one inscribed portrait-statues and fragments, perhaps the most interesting is a statue of Sen-Mut, the architect of Queen Ḥātshepset, who reigned about B.C. 1600. Ḥātshepset's name is chiefly associated with the beautiful temple at Dêr el-baḥari, on one of the walls of which is sculptured her famous expedition to the land of Punt. The erection of this temple was the chief architectural work of her reign, and Sen-Mut was the architect who carried out her instructions. In the statue found by Miss Benson he is represented kneeling and holding before him a Hathor-headed shrine, while both the body of the statue and its pedestal bear inscriptions giving his parentage and the offices he held. That Sen-Mut was the queen's favourite, and a powerful official, is well attested by the records that we have of him. Another statue of him and his funeral stela are preserved at Berlin, while his portrait is sculptured in one of the compositions at Dêr el-baḥari; from these monuments, and from an inscription on the rock at Aswân the main facts concerning Sen-Mut's career have long been known. Another find of some interest are five blocks of stone which formed part of a wall of a chamber in the temple built by Piānchi, King of Ethiopia, about B.C. 766. From the sculptures on them we learn that this monarch, following Queen Ḥātshepset's example, undertook a foreign expedition with the object of bringing the riches of the South to Thebes. The ships which formed the expedition are represented returning laden with cargo, and from the plants, palm-nuts, &c., depicted, it seems

not improbable that the expedition penetrated to the region south of Khartûm. The blocks are roughly carved, and of course, whether from an artistic or historical point of view, cannot be compared with the famous reliefs of the expedition to Punt; but they, at least, bear witness to a foreign expedition of Piānchi that is not elsewhere recorded.

It will be seen, therefore, that Miss Benson and Miss Gourlay have had some reward for their three seasons' work; and, although surface-excavation at Karnak is not a very arduous or difficult undertaking, it is not unreasonable that they should be proud of having obtained the first permission to excavate given to women in Egypt. Whether their example will be followed by other ladies remains to be seen, though we think on the whole such work is perhaps better left to the male professional digger, who can camp on the spot, and having a knowledge of Arabic is naturally better able to control his men, and can check to some extent the thefts of the smaller antiquities. Of the general plan of the book in which Miss Benson and Miss Gourlay, with Mr. Newberry's help, have published the results of their work, one word must be said. The excavation of a temple site, which results in correcting a previously published ground-plan, and in recovering a number of statues of secondary importance, is of the highest interest to the expert, but does not appeal to the general public. Yet Miss Benson has more than doubled the size of her book by adding sketches of the religion and the history of Egypt. In the preface it is stated that this has been done for the benefit of those who, "without technical knowledge, feel the fascination and interest of Egypt." But for this class of reader it cannot be said that at the present day there is any lack of sound popular histories. In fact, in describing her diggings, Miss Benson should have addressed herself only to the expert; he would have been contented with Parts ii. and v. of the book, and the result would have been a very much handier volume.

OUR BOOK SHELF.

Die Medial-Fernrohre. By L. Schupmann. Pp. 145. (Leipsig: B. G. Teubner, 1899.)

Every one is familiar in a general way with the optical parts of a reflector and refractor, the former containing in its optical series a parabolic reflector with a smaller reflector and eyepiece, and the latter consisting of an objective of two different kinds of glass for the elimination of colour, and the necessary eyepiece near the focus.

The "medial-fernrohr" and "brachymedial-fernrohr," both of which are discussed here, may each be described generally as being a combination of a refractor and reflector, for the functions of both an objective and a curved reflecting surface are required.

In the principle involved in this new method of construction it is possible to produce an achromatic telescope with the employment of only one *kind* of glass, and the author, who had a telescope made as a preliminary trial of the system he was investigating, says "derartige Systeme hatten also zur Not schon konstruiert werden können, bevor man die verschiedene Dispersion der Glasarten kannte."

The achromatism in the telescopes here under discussion is obtained by making the objective of one kind of glass, and, before the focus is reached, of intercepting the light rays by a curved mirror near the surface of which another lens of a different kind of glass is placed. The light rays thus pass twice through the second lens.

In these pages the author takes the case of the medial-fernrohr first, and discusses the optics of its system very thoroughly, using terms in the discussion which are generally considered inappreciable in other systems. The result of the investigation speaks very highly for this class of instrument, and the greater the aperture the more efficient does it seem to become. It would naturally be thought that the employment of two lenses and a reflector would tend to diminish very considerably the brightness of the image, especially as the rays pass twice through one of the lenses. We are told, however, that comparing an ordinary refractor and a "medial" of 12 cm. aperture, the brightness of the image in the case of the former exceeds that of the latter by 15 per cent.; but comparing apertures of 34 cm., the medial has the advantage of 7 per cent. For equal apertures of 1 metre the "medial" exceeds the refractor by as much as 30 per cent.

Towards the latter part of this volume the author describes the method of mounting and adjusting an instrument of large dimensions. He then discusses the "brachymedial" telescope, adapting the formulæ obtained in the previous portion of the book to this form of instrument. Here he also describes a telescope of large aperture on this principle, but although optically it does not attain the efficiency of the "medial," yet the fact, that the length of the tube is very considerably shortened by a more compact arrangement of the optical parts, may counterbalance this deficiency.

In conclusion, we recommend to our astronomical and physical readers the work before us; for it is only by such investigations that further advance in our present instrumental equipment can be made.

Mathematical and Physical Tables. By James P. Wrapson and W. W. Haldane Gee. Pp. viii + 215. (London: Macmillan and Co., Ltd., 1898.)

In these pages the compilers have brought together a most useful set of tables and formulæ which should be found of great service, both in the class-room and laboratory. The first part of the book is devoted simply to tables: these include, among others, four-place logarithms and antilogarithms, natural and logarithmic sines, cosines, and tangents, tables of squares, square roots, cube roots, &c. In the next section the reader has brought before him the chief formulæ in pure and applied mechanics; here, for example, he can find at a glance the lengths of curves, areas and volumes of solids, plane and spherical trigonometrical formulæ, formulæ used in analytical geometry, and others connected with dynamics, pendulums, elasticity, and hydraulics.

The other sections, the contents of which are too numerous to mention, consist of tables of pure and applied physics, which should be found very useful, and formulæ in pure and applied physics, which include optics, heat, magnetism, electrostatics, electro-chemistry, electro-magnetic induction, and alternating currents, &c. The volume concludes with an appendix containing other useful miscellaneous information, and an index.

If the book be used judiciously, and employed simply as a means of reminding the student of formulæ and data which may have grown rusty by disuse, its value is to be recommended; but it should not be given to young students, who would probably work out problems without knowing the why and wherefore of the expressions they are using.

For neatness and conciseness, and the numerous clearly printed diagrams, the volume will be found a desirable source of information, and considerable pains seems to have been taken to bring the data up to date.

La Photographie Animée. By Eug. Trutat, Director of the Natural History Museum, Toulouse. Pp. xii + 185. (Paris: Gauthier-Villars, 1899.)

THIS volume, introduced by a preface by M. Marey, the well-known chronophotographer of animals and human beings in motion, for purposes of study, will be found useful to all interested in the subject of animated photography.

The author devotes the opening chapter to a short review of the history of the subject, explaining the application of the phenomenon of persistence of vision in such early instruments as the phénakisticope and zootrope of Plateau and Clerk Maxwell.

He then traces the evolution of the apparatus from the multiple cameras of Muybridge, Anschutz, Londe and his own to the first employment of a fixed plate by M. Marey, and then to the continuous band machines of Marey, Edison, Demeny and others. In this chapter will be found well-illustrated descriptions of most of the French machines which have proved successful.

The third and concluding chapter deals with the various manipulations necessary for obtaining the photographs, and afterwards exhibiting them. The operations of exposure, development, and printing of the positive film are lucidly explained, and then details are given for the management of the film in the lantern

There is no doubt of the usefulness of the treatise, but its value is somewhat lessened by the descriptions being almost entirely confined to French apparatus, the author giving no signs of being familiar with the successful machines which have been produced outside his own country.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Interferometer.

THE questions raised by Mr. Preston (NATURE, March 23) can only be fully answered by Prof. Michelson himself; but as one of the few who have used the interferometer in observations involving high interference, I should like to make a remark or two. My opportunity was due to the kindness of Prof. Michelson, who some years ago left in my hands a small instrument of his model.

I do not understand in what way the working is supposed to be prejudiced by "diffraction." My experience certainly suggested nothing of the sort, and I do not see why it is to be expected upon theoretical grounds.

The estimation of the "visibility" of the bands, and the deduction of the structure of the spectrum line from the visibility curve, are no doubt rather delicate matters. I have remarked upon a former occasion (*Phil. Mag.*, November 1892) that, strictly speaking, the structure cannot be deduced from the visibility curve without an auxiliary assumption. But in the application to radiation in a magnetic field the assumption of symmetry would appear to be justified.

My observations were made with a modification of the original apparatus, which it may be worth while briefly to describe. In order to increase the retardation it is necessary to move backwards, parallel to itself, one of the perpendicularly reflecting mirrors. Unless the ways upon which the sliding piece travels are extremely true, this involves a troublesome readjustment of the mirror after each change of distance. The difficulty is avoided by the use of a fluid surface as reflector, which after each movement automatically sets itself rigorously horizontal. If mercury be contained in a glass dish, the depth must be considerable, and then the surface is inconveniently mobile. A better plan is to use a thin layer standing on a piece of copper plate carefully amalgamated. A screw movement for raising and lowering the mercury reflector is still desirable, though not absolutely necessary.

RAYLEIGH.

Theory of Functions.

IN his review of our book on "Analytic Functions" (NATURE, February 23), Prof. Burnside makes three specific charges of inaccuracy; we shall show that the inaccuracy is his, not ours.

(1) One charge relates to the difference of two convergent series. There is an elementary and well-known theorem which states that the difference of two convergent series $\sum_1^\infty a_n$ and $\sum_1^\infty b_n$ is equal to $\sum_1^\infty (a_n - b_n)$, no matter whether the convergence of the series be unconditional or conditional. Prof. Burnside has, then, fallen into a very serious error when he says of this very operation of subtraction that "the rearrangement involved is one which cannot be used with conditionally convergent series, as indeed the authors have shown most clearly in an earlier chapter." We must add that there is no "rearrangement," and that we have tried in § 68 to put the reader on his guard against this very error of Prof. Burnside.

(2) A second charge relates to infinite products. In § 109 we consider a certain infinite product $\Pi(1 - \alpha_n)$; in regard to this product, Prof. Burnside complains that we have not explained "what is implied in calling such a product convergent." As a matter of fact we treat an infinite product as an instance of an infinite sequence, and convergence for infinite sequences has been already explained in § 47. He falls into another inaccuracy when he says that "if $\Sigma\alpha_n$ is greater than unity, all that has been proved is that $\Pi(1 - \alpha_n)$ is less than unity and greater than some definitive negative quantity." We have proved much more than this, namely that there is a limit for the numbers $\prod_1^n(1 - \alpha_n)$, when n tends to infinity (see § 45).

We did not intend to go into the case where the sequence associated with an infinite product converges to zero, because there is as yet no final agreement as to whether the product is or is not to be called convergent in this case. The product in § 109 does not converge to zero. Prof. Burnside does not allude to this point; but we should like, nevertheless, to take this opportunity of saying that we ought to have added a proof that the convergence of $\Sigma\alpha_n$ excludes this special case, instead of assuming that the reader knows the proof, as given, for instance, in Hobson's "Trigonometry."

(3) The third charge relates to our use of the word "infinity" on p. 3. This word "infinity," in the earlier parts of the higher arithemetic, has but one accepted meaning; to quote the words of M. Tannery, "la notion de l'infini dont il ne faut pas faire mystère en mathématiques se réduit à ceci; après chaque nombre entier il y en a un autre." We have used the word "infinity" in this, its legitimate sense. Failure to perceive the "variable" character of infinity has led to many misconceptions in the past. We cannot understand Prof. Burnside's objection except on the supposition that he has, for the moment, confused this "variable" infinity with the discredited "constant" infinity.

On the score of accuracy we wish to point out that we gave two chapters to elliptic functions, not three, as the reviewer states; and that Log x is not *defined* (the italics are the reviewer's) by means of a piece of string and a cone. We *define* the logarithm by means of an equiangular spiral, in a way somewhat similar to that used in Clifford's "Common Sense of the Exact Sciences," and we indicate, incidentally, a mechanical construction of the curve.

It is always an ungracious task to reply to a review, especially when it is in general appreciative, and written by a mathematician of acknowledged standing; but in the circumstances we felt that we had no alternative. We believe that Prof. Burnside will be the first to recognise that his specific criticisms are based on misconceptions.

J. HARKNESS.
F. MORLEY.

Philadelphia, March 14.

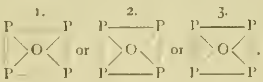
THE criticism on the passage quoted from p. 3 of the book by Profs. Harkness and Morley (NATURE, February 23, p. 347) turns on the fact that, in dealing with number divorced from measurement, the authors have used the phrase "an infinity of objects" without an explicit statement of its meaning. I am not sure that I understand the passage in their letter which refers to this point; but it seems to me to imply that the distinction between "finite" and "infinite" is one which does not require definition. This is not the only accepted view. It is not, for

instance, the view taken in Herr Dedekind's book, "Was sind und was sollen die Zahlen." As regards the opening sentences of Chapter xv., the authors have apparently misunderstood the point of my objection. With the usually received definition of convergence of an infinite product, $\Pi(1-a_n)$, if convergent, is different from zero. So far as the passage quoted goes, $\Pi(1-a_n)$ might be zero; and it is therefore not shown to be convergent, if the usual definition of convergence be assumed. As to the passage quoted from p. 232, I must express to the authors my regret for having overlooked the fact that the particular rearrangement, there made use of, has been fully justified in Chapter viii. Whether Log x is or is not, at the beginning of Chapter iv., defined by means of a string and a cone, will be obvious to any one who will read the whole passage (p. 46, line 16, to p. 47, line 9) leading up to the definition.

W. BURNSIDE.

The Tetravalency of Oxygen.

THE discovery of the new and easy method of preparing the pure oxygen phosphide OP_4 (or Le Verrier's phosphorus suboxide) by the acidification of the solution of phosphorus in "alcoholic potash," should draw attention to the remarkable fact that the oxygen atom can be therein symmetrically represented *only* as tetravalent and not divalent, and that it is probably an inorganic, non-carbon, closed-ring molecule:—



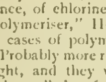
Without discussing the valency or "validity," as I have termed it, of phosphorus, my point is that oxygen is here tetravalent. The silver analogue (?) OAg_4, or

is known. And doubtless others. There ought, therefore, to be no further hesitation in definitely accepting the oxygen atom in the CO molecule as tetravalent, and in proceeding with investigations which shall elucidate, in terms of physical chemistry, the remarkable fact of the "alternating valency" of the non-metallic atoms. Oxygen has as clearly two valence values as phosphorus and nitrogen.

The change in the valency of oxygen seems to be connected with "polymerisation." In 1888 I wrote in the *Philosophical Magazine*, vol. xxv. p. 232:—

"The stimulus—if I may so term it—to polymerisation in these cases seems to be due to the development, in ways that current research are seeking to explain, of the higher valency, or, as it may be preferably termed, the validity of oxygen, or the tervalidity, for instance, of chlorine in "hydrochloric acid solution" used as "a polymeriser," H—Cl = =. It is significant that there are few cases of polymerisation where oxygen is not concerned. . . . Probably more ring formulæ in *in*organic bodies will come to light, and they will affect the maypole hypothesis—as it may be called—of the domination of the central polad atom."

This prediction has, I believe, since been verified, and the benzene-ring style of Kekulé is no longer viewed as exclusively characteristic of carbon. The remarkable volatile osmium compound is probably



where oxygen is tetravalent as it is in Friedel's $(H_3C)_2OCH$l.

I would, therefore, venture to suggest that possibly my two papers in the *Phil. Mag.* may still be worth half an hour's attention from gentlemen who would find some curious compounds therein discussed—compounds whose physical chemistry may perhaps now be found worth examination in the light of the newer methods, and also in the light of the developing investigations concerning the ether and the intra-molecular equipoise of the atoms constituting the chemical molecule.

Banbury, March 25. J. F. HEYES.

THE PROGRESS OF WIRELESS TELEGRAPHY.

WE recently referred to the first messages transmitted over the English Channel between the South Foreland and Boulogne by Marconi's system of wireless telegraphy. During last week the English station was visited by Prof. Fleming, who has written his experiences to the *Times*.

An idea of the present state of the problem can be conveniently gathered from this communication. First as to the certainty of the results obtained, Prof. Fleming states:

"Throughout the period of my visit messages, signals, congratulations, and jokes were freely exchanged between the operators sitting on either side of the Channel and automatically printed down in telegraphic code signals on the ordinary paper slip at the rate of twelve to eighteen words a minute. Not once was there the slightest difficulty or delay in obtaining an instant reply to a signal sent. No familiarity with the subject removes the feeling of vague wonder with which one sees a telegraphic instrument merely connected with a length of 150 feet of copper wire run up the side of a flagstaff begin to draw its message out of space, and print down in dot and dash on the paper tape the intelligence ferried across thirty miles of water by the mysterious ether."

Signor Marconi by much work has arrived at great simplicity.

"With the exception of the flagstaff and 150 feet of vertical wire at each end, he can place on a small kitchen table the appliances, costing not more than 100*l*. in all, for communicating across thirty or even one hundred miles of channel. . . . The distance to which effective signalling extends varies as the square of the height of the rod. A wire 20 feet high carries the effective signal one mile, 40 feet high four miles, 80 feet sixteen miles, and so on."

We are very glad to print the following extract from Prof. Fleming's letter:

"The general public are not much concerned with questions of priority or with the claims or suggestions of rival experimentalists, but they are interested in ascertaining the serious possibilities of that which has been actually achieved. Signor Marconi has never hesitated to acknowledge that he has built upon the foundations laid by others, but a vast gulf separates laboratory experiments, however ingenious, from practical large scale demonstrations conducted with all that regularity and freedom from failure which is the absolute condition of their public utility.

"I cannot help thinking that the time has arrived for a little more generous appreciation by his scientific contemporaries of the fact that Signor Marconi has by minute attention to detail, and by the important addition of the long vertical air wire, translated one method of space telegraphy out of the region of uncertain delicate laboratory experiments and placed it on the same footing as regards certainty of action and ease of manipulation, so far as present results show, as any of the other methods of electric communication employing a continuous wire between the two places. This is no small achievement."

There can be no doubt that what this system will do in the future for those who live on coast-lines or go down to the sea in ships is destined to be of great importance. Already the usefulness of light-ships is increased tenfold. The fleet manœuvres of the future may be flagless. Sea routes by means of an international concert pitch may be turned into exchanges—but there is no end of the possibilities thus opened out by this new development of the results of the study of the "useless."

Prof. Fleming, in the course of his long and interesting letter, points out the importance of some new Board of Trade regulations "for the use of the ether"—the term is distinctly good—lest vagrant electric waves should interfere with the official ones. Even the ether, then, may yet be dismissed with costs.

A CHAPTER IN THE HISTORY OF SPECTRUM ANALYSIS.

WHEN I began to endeavour to apply the principles of spectrum analysis to the investigation of the nature of the heavenly bodies in 1865, the then idea, based upon Kirchhoff and Bunsen's work of 1859, was

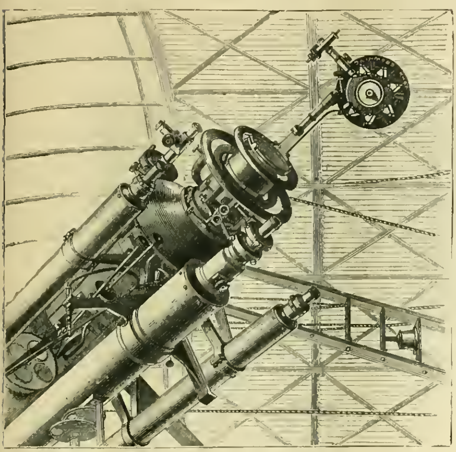


FIG. 1.—Spectroscope attached to a large refractor which throws an image of the sun on the slit plate.

that the spectrum of a chemical element was one and indivisible—that it could not be changed by temperature or by anything else.

Looking back it is easy to see now that this idea largely depended upon the fact that in the early days low flame temperatures were generally employed, and that it so happens that the substances best visible in the flame, and which were therefore chosen to experiment upon, such as sodium, calcium, potassium, and the like, give us line spectra at low stages of heat.

Hence the first spectroscopic ideas entirely agreed with those of the chemist, that the chemical "atom," defined by a certain "atomic" weight was a manufactured article, indivisible, indestructible. Chemical elementary substances were either composed of these atoms, these indivisible units, or of "molecules" consisting of one or two of them, hence the terms "monatomic" and "diatomic" molecule.

The difference between the spectra of the same element in the solid and gaseous states, in which we have first a continuous and secondly a line spectrum, was ascribed to the restricted motion of the atom in the solid and its freedom in the gaseous state—it was a question of "free path." The difference between the states which gave us the continuous and discontinuous spectra was a physical difference having nothing to do with chemistry. According to the kinetic theory of gases, the particles of all bodies are in a state of continual agitation, and the difference between the solid, liquid and gaseous states of matter is that in a solid body the molecule never gets beyond a certain distance from its initial position. The path it describes is often within a very small region of space. Prof. Clifford, in a lecture upon atoms, many years ago illustrated this very clearly. He supposed a body in the middle of a room held by elastic bands to the ceiling and the floor, and in the same manner to each side of the room. Now pull the body from its place; it will vibrate, but always about a mean position; it will not travel bodily out of its place; it will always go back again.

We next come to fluids. Concerning these we read: "In fluids, on the other hand, there is no such restriction to the excursions of a molecule. It is true that the molecule generally can travel but a very small distance before its path is disturbed by an encounter with some other molecule; but after this encounter, there is nothing which determines the molecule rather to return towards the place from whence it came than to push its way into new regions. Hence in fluids the path of a molecule is not confined within a limited region, as in the case of solids, but may penetrate to any part of the space occupied by the fluid.

Now we have the motion of the molecule in the solid and the fluid. How about the movement in a gas? "A gaseous body is supposed to consist of a large number of molecules moving very rapidly." For instance, the molecules of air travel about twenty miles in a minute. "During the greater part of their course these molecules are not acted upon by any sensible force, and therefore move in straight lines with uniform velocity. When two molecules come within a certain distance of each other, a mutual action takes place between them which may be compared to the collision of two billiard balls. Each molecule has its course changed, and starts in a new path.

The collision between two molecules is defined as an "encounter"; the course of a molecule between encounters a "free path." "In ordinary gases the free motion of a molecule takes up much more time than is occupied by an encounter. As the density of the gas increases the free path diminishes."

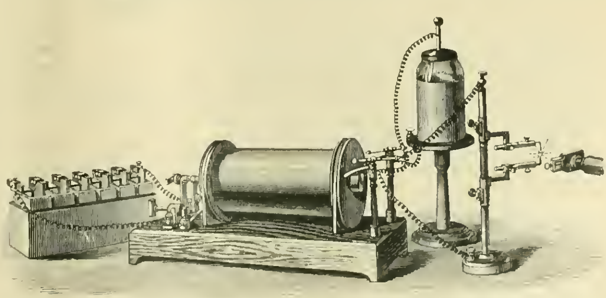


FIG. 2.—The first method of work with the slit of the spectroscope close to the light source. In the experiment illustrated the light source is an electric spark produced by an induction coil with Leyden jar in circuit. The slit end of the collimator is shown to the right.

It will be seen at once that on the view first held that the difference between continuous and discontinuous spectra depended simply upon the solid and gaseous states, no solid could give us a line spectrum; and the well-known absorption spectra of didymium glass and other solid bodies would be impossible.

Another important series of facts was soon brought to the front. Plücker and Hittorf in the year 1865 announced that "there is a certain number of elementary substances which when differently treated furnish two kinds of spectra of quite a different character, not having any line or band in common." The difference in character to which reference is here made consists in the spectrum produced at the lower temperature being composed of flutings, which are replaced by lines when the higher temperature is reached.

This was the first blow aimed at the general view—one element one spectrum—to which I have referred above. It was met in two ways.

Taking the line spectrum as representing the true vibration as the chemical unit, I have already shown that the continuous spectrum was explained as due to its physical environment, the solid or liquid state. This, then, had not to be considered from the chemical point of view.

The fluted spectra were boldly ascribed to "impurities," but not always wisely, for, to get rid of the difficulty presented by the two spectra of hydrogen, two perfectly distinct spectra were ascribed to acetylene. Again the "bell-hypothesis" was suggested, according to which the spectrum did not depend so much upon the substance as upon the way it was made to vibrate. According to this view the same chemical "atom" might have a dozen spectra if struck in a dozen different ways.

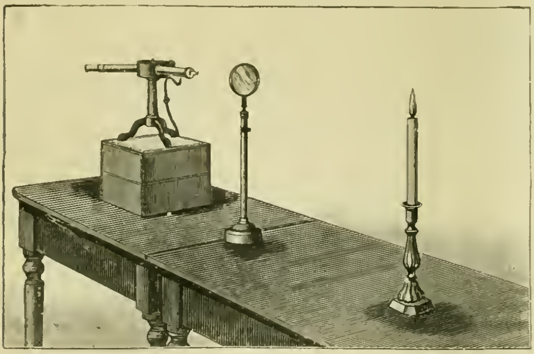


Fig. 3.—The method of throwing an image of the light source (in this case a candle flame) on the slit plate of a laboratory spectroscope.

But it was answered that this argument proved too much; and for this reason. Mitscherlich showed in 1864 that some bodies known to be chemical compounds when raised to incandescence, give us a spectrum special to the compound; that is, they have a spectrum of their own; no lines of either of the constituents are seen.

I showed later that when the temperature was sufficient to produce decomposition the lines of the elementary bodies, of which the compound was composed, made their appearances according to the temperature employed. And I also showed that precisely the same thing happens with regard to the fluted and line spectra of the same chemical element. We may get the first alone at a low temperature. We may increase the temperature and dim it slightly, some lines making their appearance; and next, by employing a very high temperature, we can abolish the fluted spectrum altogether and obtain one with lines only.

Since then the difference between the two spectra of the same element was no more marked than the difference between the spectrum of a known compound and its constituents after the compound had been broken up by heat; it was as logical to deny the existence of compound bodies as to deny that more molecular complexities than one were involved in spectral phenomena.

Attacks like these finally caused the chemists to reconsider their position, and some time later, being under the impression, which has turned out to have no justification, that "monatomic" elements like mercury have not fluted spectra, they conceded that the fluted spectra might represent the vibration of the "diatomic" molecule in the "diatomic" elements. This, of course, was to give up the "bell-hypothesis."

At the time when the differences of opinion arising from the existence of fluted as well as line spectra in the case of many elements were being discussed, solar observations were beginning to bring before us a perfect flood of facts apparently devoid of any law or order. In 1866 I threw an image of the sun on the slit of a spectroscope (Fig. 1), in order to observe the spectra of its different parts, and in this way the spectra of sun-spots and eventually of prominences were observed.

In the first method of work adopted in the laboratory the spectroscope was directed to the light source, so that the spectrum was built up of the light coming from all parts of it without discrimination (Fig. 2).

In 1869 I introduced into laboratory work the method adopted in the case of the sun in the observatory; that is, an image of each light source experimented on was thrown on to the slit by a lens (Fig. 3), so that the spectrum of each part of it could be observed, and some of the results obtained by the new method were the following:

The spectral lines obtained by using such a light source as the electric arc or spark were of different lengths; some only appeared in the spectrum of the centre of the light source, others extended far into the outer envelopes. This effect was best studied by throwing the image of a horizontal arc or spark on a vertical slit. The lengths of the lines photographed in the electric arc of many metallic elements were tabulated and published in 1873 and 1874 (Figs. 4 and 5).

Here then was the first glimpse of the idea that the complete spectrum of a chemical element obtained at the highest temperature might arise from the summation of two or more different line spectra produced at different degrees of temperature, and therefore bringing us in presence of two or more molecular complexities; that is, different molecules broken up at different temperatures. So soon as experiments in the laboratory had given a definite result with regard to the spectrum of a metal in this way, I proceeded to study the sun with a view of determining how that metal behaved in the sun.

This involved, first, photographs of the solar spectrum with its dark lines, photographic comparisons of these dark lines with the bright lines constituting the spectra of the metallic elements. This enabled us to compare the total light given by each light source with the light received from all parts of the sun indiscriminately.

Next the spectra of different parts of the sun—chromosphere and prominences and spots—were compared with different parts of the light source, the core of the arc, and the centre of the spark, and the outer regions of both.

It will be seen that the inquiry now had a very broad base, and it could be immediately tested in many ways at every stage.

Wonderful anomalies were at once detected, lines known to belong to the same chemical element behaved differently in several ways. Some were limited to spots, others to prominences, and in solar storms different iron lines indicated different velocities. In the spectrum of the hottest part of the sun open to our inquiries, the region namely immediately overlying the photosphere which I named the chromosphere the anomalies became legion; suffice to say that in the hottest part of the sun we could get at, the spectrum of iron then represented in Kirchhoff's map by 460 lines in the ordinary solar spectrum was reduced to three lines.

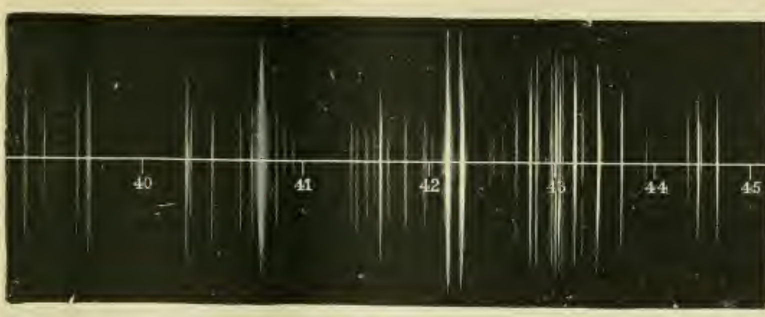


FIG. 4.—The long and short lines. Copy of a photograph taken with a vertical slit when compounds of strontium and calcium were volatilised between horizontal carbon poles.

It was no longer a question merely of settling the difficulties raised by the observations of Plücker and Hittorf.

Many observations and cross references of this kind during the next few years convinced me that the view that each chemical element had only one line spectrum

FIG. 5.—The longs and shorts of sodium taken under the same conditions, showing that the orange line extends furthest from the poles.

was erroneous, and that the results obtained suggested that the various terrestrial and solar phenomena were produced by a series of simplifications brought about by each higher temperature employed. That is, that the new instrument, the spectroscope, showed that higher temperatures than those previously employed were doing for chemistry what previous similar inquiries had done; namely, indicating the existence of finer constituents in matter supposed at each point of time to be elementary.

This was the first glimpse of dissociation in relation to the production of changes in the line spectrum.

By the year 1872 the work of Rutherfurd and Secchi on stellar spectra enabled the base of the inquiry to include the stars as well as the sun. In some of the stars the existence of hydrogen, magnesium and carbon were beyond question. The point that first struck me was that in white stars like α Lyræ and Sirius, with continuous spectra extending far into the violet—stars therefore hotter than their fellows of a yellow or red colour—we had to do with hydrogen almost alone.

It was in 1873 that I first called the attention of the Royal Society to the very remarkable facts which had even then been brought together regarding the possible action of heat in the sun and stars. Referring more especially to the classification of stars by Rutherfurd, I wrote as follows:[1]

"I have asked myself whether all the above facts cannot be grouped together in a working hypothesis which

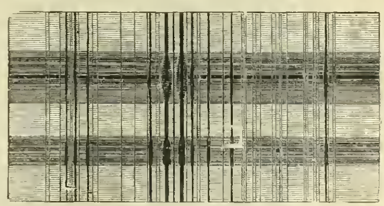


FIG. 6.—Spectrum of a sun-spot as compared with the general spectrum, showing that certain metallic lines (sodium and calcium in this instance) are widened. The darker portion represents the spectrum of the spot.

assumes that in the reversing layers of the sun and stars various degrees of 'celestial dissociation' are at work, which dissociation prevents the coming together of the atoms which, at the temperature of the earth and at all artificial temperatures yet attained here, compose the metals, the metalloids, and compounds."

Subsequently in a private letter to M. Dumas, who took the keenest interest in my solar work, I wrote, "Il semble que plus une étoile est chaude plus son spectre est simple."

[1] *Phil. Trans.*, vol. clxiv. part 2, p. 491.

I also pointed out the close relation of hydrogen to calcium, magnesium, and other metals (it was on this ground that I had named the substance which gave D^3, which always varied with hydrogen, helium), and the absence of all other terrestrial gases from the solar spectrum. An interesting discussion at the Paris Academy of Sciences was thus concluded by M. Dumas:

“En résumé, quand je soutenais devant l'Académie que les éléments de Lavoisier devaient être considérés, ainsi qu'il avait établi lui-même, non comme les éléments *absolus* de l'univers, mais comme les éléments *relatifs* de

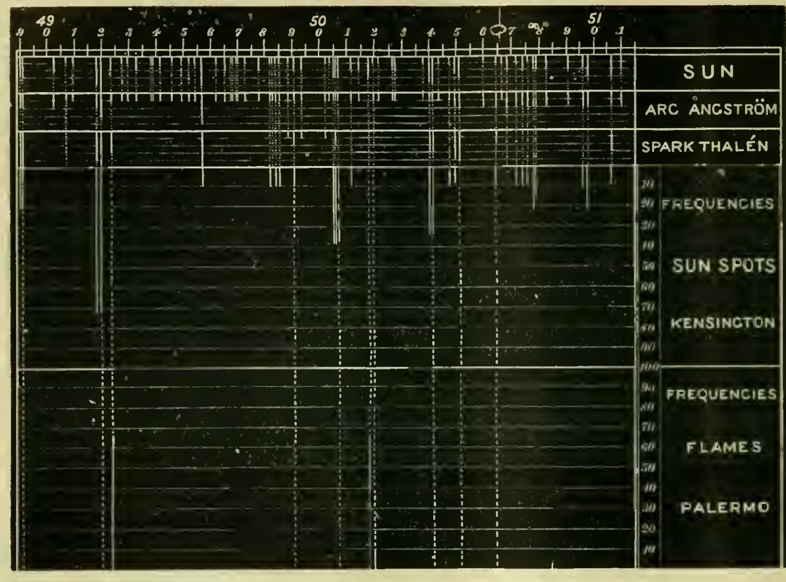


Fig. 7.—Iron spot lines at Kensington confronted with iron prominence lines at Palermo.

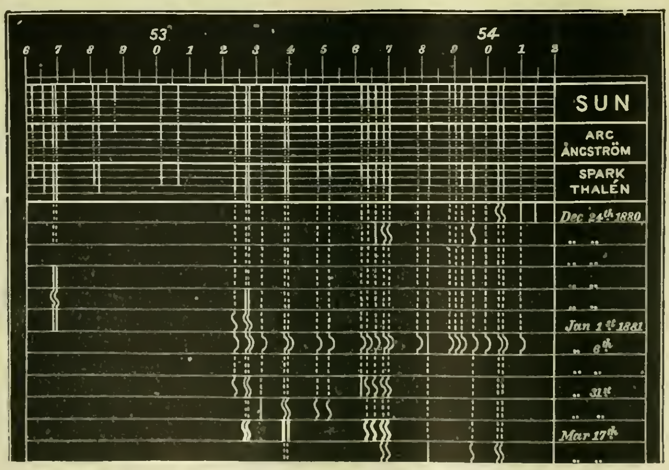


Fig. 8.—Different rates of motion registered by different iron lines.

l'expérience humaine; quand je professais, il y a longtemps, que *l'hydrogène* était plus près des métaux que de toute autre classe de corps; j'émettais des opinions que les découvertes actuelles viennent confirmer et que je n'ai point à modifier aujourd'hui."[1]

One of the replies to my working hypothesis was that the various chemical elements probably existed in different proportions in the different stars, and that it so happened that in Vega and Sirius one of them, hydrogen, existed practically alone.

In 1878 I went further, and showed that thousands of solar phenomena which had been carefully recorded during the previous years could only be explained by assuming that the changes in the various intensities of lines in the line spectrum itself indicated successive dissociations. I pictured the effect of furnaces of different temperatures, and I wrote as follows:[2]

"It is abundantly clear that if the so-called elements, or, more properly speaking, their finest atoms—those that give us line spectra—are really compounds, the compounds must have been formed at a very high temperature. It is easy to imagine that there may be no superior limit to temperature, and therefore no superior limit beyond which such combinations are possible, because the atoms which have the power of combining together at these transcendental stages of heat do not exist as such, or rather they exist combined with other atoms, like or unlike, at all lower temperatures. Hence association will be a combination of more complex molecules as temperature is reduced, and of dissociation, therefore, with increased temperature, there may be no end."

In 1878 I went back to the study of the changes in the line spectra in relation to the changes observed when known compounds were dissociated, and after discussing certain objections I submitted the conclusion that the known facts with regard to the changes in line spectra "are easily grouped together, and a perfect continuity of phenomena established on the hypothesis of successive dissociations analogous to those observed in the cases of undoubted compounds."[3]

It is thus seen that the conclusions to which my spectroscopic work up to the year 1880 had led me, tended in exactly the same direction as that indicated by more purely chemical inquiries thus referred to by Berthelot in that year:—

"L'étude approfondie des propriétés physiques et chimiques des masses élémentaires, qui constituent nos corps simples actuels, tend chaques jour d'avantage à les assimiler, non à des atomes indivisibles, homogènes et susceptibles d'eprouver seulement des mouvements d'ensemble, . . . il est difficile d'imaginer un mot et une notion plus contraires à l'observation; mais à des édifices fort complexes, doués d'une architecture spécifique et animés des mouvements intestins très variés."[4]

NORMAN LOCKYER.

DRIFT-BOTTLES AND SURFACE CURRENTS.

THE rather anomalous results arrived at by some recent investigators who have employed the float or bottle method of ascertaining the surface movements of the waters of the sea, make the discussion of a large number of these observations of special value at the present time. Such is to be found in Dr. Schott's able and elaborate paper on the "Flaschenposten" in the possession of the Deutsche Seewarte, published a short time ago in the *Archiv*.

After an historical introduction, in which it appears that the earliest recorded current observation of this kind is about a century old, Dr. Schott describes the material at his disposal, which consisted of about 600 records found up to the end of the year 1896. One important point here brought out is that no consistent difference can be observed in either direction or rate of drift between empty floats and floats loaded so as to ensure complete immersion.

In arranging the records obtained from each of the great oceans, the first place is, of course, given to the North Atlantic, which includes no less than 452, or 70 per cent. of the whole. The North Atlantic records are subdivided into six sections—those from floats set adrift in the North Sea and the English Channel; in the west wind region north of 30° N. lat.; in the north-east trade wind region; those in the south-east trade wind region which were recovered beyond its northern limit; those in the region of south-west monsoons, and in the Mediterranean. The charts appended to the paper, of which we reproduce a specimen, contain only a selected number of the drift-tracks dealt with; full details are given in tabular form. In the case of the other oceans, the whole of the observations are represented; the South Atlantic and the Pacific are each treated as a whole, while the Indian Ocean is divided into the monsoon region, the south-east trade belt, and the "brave west winds."

Summing up in a final paragraph, Dr. Schott concludes that on the whole the method of drift-bottles yields valuable information both as to the direction and speed of surface currents. From this, however, the monsoon regions are expressly excepted: the number of bottles found within the period of one monsoon is necessarily small, and the few found give unsatisfactory results. As specially favourable instances, Dr. Schott quotes his results in the Bay of Biscay, disproving the existence of Rennell's current (no reference is made, by the way, to the work of Hautreux); in the West Indies, where the concentration of immense quantities of surface-water from the coast of Portugal and from the South Atlantic is clearly shown; in the west wind drift of the southern hemisphere, and in the splitting of the southern equatorial current off the east coast of Madagascar. In this connection special stress is rightly laid on the record of two bottles, one loaded with sand and the other not, thrown overboard from the s.s. *Paranagua* in 13° 49′ N. lat. and 25° 34′ W. long., and picked up together on the island of Santiago (Cape Verd Island) after a journey of 131 miles in twenty-one days, the direction being north-east by east *with* a weak current (whose existence was shown by independent observations recorded in ships' logs), and *against* the wind blowing at the time. In estimating the *speed* of current, the float method is found to be much less valuable, inasmuch as we can rarely be certain that the float is picked up immediately after it has reached the spot where it is found. Reasonably accurate estimates can only be looked for where a number of floats gives approximately the same result.

The justness of Dr. Schott's conclusions, so far as they go, seems to admit of little doubt, but we could have wished that his final statement of them, which will probably be much more widely read than the detailed discussion in the body of the memoir, had been expressed in a more guarded manner, and that to it he had added a note of warning, pointing out not only the extremely limited nature of the information afforded by the method, but the great risk of misinterpreting its results. Taking first the question of *direction* of surface currents: on the whole, the surface currents in perfectly open sea, clear of all land influences, follow the direction of the wind, and the float or bottle naturally takes the course common to both. Near land, the direction of the surface current is determined by three factors: first, and most important, the form of the coast line; second, the prevailing wind; and third, a gravity factor, due to

[1] "Chemistry of the Sun," p. 205.
[2] *Proc. Roy. Soc.*, vol. xxviii. p. 169. See also "Chemistry of the Sun," chap. xviii.
[3] *Roy. Soc. Proc.*, vol. xxviii. p. 179.
[4] *Comptes rendus*, 1880, vol. xc. p. 1512.

differences of level caused by off- and on-shore winds, inequalities of density, &c. In this second case the current may, and often does, move in a direction forming a considerable angle with the wind; and the float may in most cases follow the current. That it does so in certain cases Dr. Schott has shown; but nearly every paper on this subject contains "erratics," and this is no exception. Several records are distinctly unsatisfactory; the most flagrant case is, perhaps, that of two identical floats started together in 1° 44′ N. lat. and 27° 16′ W. long., one of which was found on the coast of Nicaragua, and the other on the coast of Sierra Leone. Compare this with Mr. Russell's results on the east coast of Australia. "In view of the well-known southerly current on this coast, it is remarkable that so few of the papers found seem to go with it, and that the majority of the papers found go against the current." Evidently great caution is necessary in applying the method. What seems most likely is that the relation of the movement of the float to that of the wind and of the surface water is really a function of the strength of the wind and the sea disturbance, and of the density of the water. A float may make headway with a current against a light wind; but if it meets with a cyclone, it, and perhaps a skin of water with it, may be removed from the surface of the current, a merely local disturbance transferring it to another member of the oceanic circulation: yet the "record" of this float would show the two currents as a continuous stream.

With regard to deductions as to the speed of a current based on records from floats, we are almost inclined to go further than Dr. Schott, and to regard such as practically valueless. The whole tendency of recent investigation has been to show that steady forward movement of surface water only occurs when there is a distinct "head" of water strongly controlled by the shape of the land; the best examples being the north and south currents moving polewards on the eastern sides of the great land masses. These currents come to an end as soon as they get clear of the land, and their waters are distributed by "drift" currents controlled primarily by the prevailing winds, but subject to continual variation, according to the relative amounts of denser and lighter water supplied by the true currents. But the movements of the drift currents are irregular in the extreme; the water goes backwards and forwards, the horizontal course of any particle of water, perhaps, resembling that of a particle of the air in the winds which drive it. The track of the *Fram* across the Polar Sea is probably a generalised form of such a course. In effect, there is no "river in the ocean," and we are not in general justified in joining the beginning and end of the course of a float by a continuous line. Under these circumstances, one is inclined to suspect that the wind has a considerable share in the high average velocities sometimes obtained for surface drifts from float observations.

Dr. Schott says little or nothing about the precise limitations which are to be observed in the interpretation of the float records, and it seems a pity that here

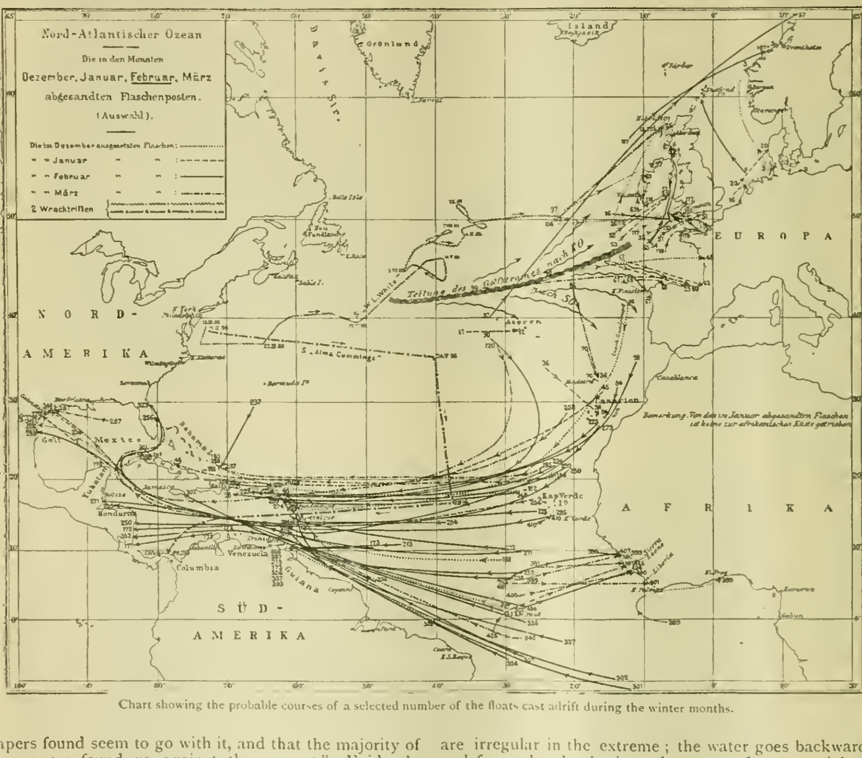


Chart showing the probable courses of a selected number of the floats cast adrift during the winter months.

again there is no note of warning. Assuming, for the moment, that floats give a trustworthy record of the movement of the surface water in which they are immersed, they give little information about the real motion of any body of water in their course. A single example must suffice to illustrate this. Set a float adrift in the Gulf of Mexico, and it is found in the Shetland Islands; we cannot conclude that water has come from the Gulf of Mexico to the Shetlands—the current which brought the float to the banks of Newfoundland may have there become an under-current, and the float cannot follow it; it remains on the surface, and is borne eastward by water which may have come from Davis Strait or Denmark Strait, where no floats are set adrift. No doubt the fact that the float took the course it did is interesting, and with sufficient knowledge of the mechanism, obtained from other sources, it may be of great value; but even in a simple case, like that quoted, the greatest caution must be exercised, and the uncertainty becomes still greater in channels and enclosed seas.

It seems fair, from Dr. Schott's discussion, to conclude that observations by means of floats are likely to contribute valuable additions to our knowledge of the surface movements of the waters of the sea, when taken in conjunction with systematic observations by more precise methods, of which the distribution of temperature and salinity is probably the most satisfactory. Taken by themselves, the float observations are liable to be seriously misleading. H. N. D.

A COMPARATIVE STUDY OF VISUAL ACCOMMODATION.

So recently as five years ago but little was known with certainty regarding the refraction and accommodation in animals with "camera eyes." It is Beer's[1] credit to have made an exhaustive investigation of a large number of animals with the aid of all modern ophthalmic methods, in addition to an experimental method of his own devising, namely, electrical stimulation of the enucleated eye.

No mechanism for accommodation is known in the facetted eyes of crabs and insects; according to Exner it is not required. The retina is comparatively thick, and moving an object from 80 cm. to 1 mm. from the eye causes an alteration of but ·01 mm. in the position of the image.

A similar argument was supposed to hold good for the rabbit's eye, even by such a distinguished physiologist as Magendie; but this was due to an experimental error. Kepler, although ignorant of accommodation, recognised, nevertheless, that the image on the retina must be sharp for visual purposes.

Speaking generally, an eye must be able to accommodate proportionally to (1) its own size, (2) the width of the pupil, (3) the closeness of the retinal mosaic. Whilst, therefore, an emmetropic man can see plainly at 6 m. without exercising his accommodation, those animals—and there are many—with much larger eyes must, for the same acuity of vision, already accommodate at that distance. On the other hand, it is not so important for large animals to have so near a "near-point" as small animals. Small animals, *e.g.* birds, have to see objects clearly even when quite close; they require a large range of accommodation. Larger animals, except monkey and man, who bring things close to the eye with the hand, can get on with a "near-point" of 1–½ m., corresponding to a range of accommodation of 1–2 diopters; this is so with the horse and ruminants.

Three modes of accommodation are possible: (1) alteration in the refractive power of the various media; (2) alteration of the curvature of the refracting surfaces; (3) alteration of the relative position of lens and retina.

This first method, by which Grimm in 1785 sought to explain accommodation, has never been actually observed. The last was formerly a favourite theory. It was taken up by Kepler and by Scheiner. Many absurd reasons were given, and mechanical hypotheses constructed by various individuals to support this theory; nobody thought of examining the actual facts. In certain classes of animals, viz. cephalopoda, fishes, amphibia and reptiles, accommodation is effected by alteration of the distance between lens and retina. In man, however, as in all mammalia, also in birds, lizards and tortoises, this is brought about by alteration in the curvature of the lens.

It is also obvious that active accommodation may be for a near (positive) or for a far (negative) point, viz. the resting eye may be adjusted for distance or proximity respectively.

The dibranchiate cephalopoda are the only invertebrates in which accommodation has been observed; and, although they have "camera eyes," their type, as a whole, is far inferior to that of vertebrates. By retinoscopy it was determined that their eye is normally adjusted for the near-point. The extent of this normal myopia varies between two and (as an extreme limit) ten diopters. The mechanism of accommodation is as follows:—The bulb forms half of a rough ellipsoid. At the equator is a flat, strong cartilaginous ring, separating the anterior flattened portion of the eye from the posterior ellipsoidal part. Behind the ring the sclerotic is comparatively soft and yielding. In the anterior wall of the eye is also a strong muscular ring with radial fibres running from the cartilaginous ring to the ciliary body, which is firmly attached in the equatorial region of the lens. When this muscle contracts it pulls back the whole anterior wall of the eye, including the ciliary body and lens, towards the interior of the eye. The resulting increased pressure would tend to make the bulb of more spherical shape, with consequent increase of distance between lens and retina, but the thinner consistency of the posterior half leads to an actual diminution of the antero-posterior diameter, and consequent approximation of retina to lens. The iris, which lies practically outside the bulb, and also serves as lid, although extremely sensitive to light, takes no part in accommodation.

Teleostean fishes, although the structure of their eye bears a superficial resemblance to that of the cephalopod eye by virtue of the spherical form of the lens, but is in other respects vertebrate in structure, are, nevertheless, myopic and accommodate for distance. The thickness of the retina, with its sensitive layer on the outer side (in the cephalopoda it is on the inner side), introduces a factor which has to be taken into account when estimating the refraction. Thus an apparently hypermetropic eye may prove to be really myopic. The comparative opacity of water, which does not allow of distinct vision for any great distance, accounts for their permanent myopia, but their range of accommodation is sufficient to enable fishes to focus parallel rays on the retina. But since their cornea is not, as was formerly supposed, flattened, when taken out of water they are so highly myopic that the correction which they possess would be of no value or account. The mechanism of the adjustment is different to that of the cephalopoda, and quite different to that of the vertebrata.

Ciliary body, ciliary muscle, zonula, spaces of Fontana do not exist in fish-eyes, and the iris does not glide on the lens, but is generally quite free. The spherical lens is suspended from above by a strong triangular band; below is the structure known as the "companula," which, from its function, Beer re-names the "retractor lentis"; it draws back the lens nearer to the retina during accommodation. This can be seen on electrical stimulation of the recently enucleated bulb, even after removal of the cornea.

[1] "The Accommodation of the Eye in the Animal Kingdom." By Th. Beer, Lecturer on Comparative Physiology in the University of Vienna.

Although the muscle is unstriped, it acts quicker than the iris. Accommodation is paralysed by atropin in fishes, but not in cephalopoda.

Even deep-sea fishes, living at a depth where the light does not affect a photographic plate exposed for a whole day, possess an accommodating apparatus.

Amphibians that accommodate, usually do so for near objects; not, however, like most other animals, by altering the curvature of the lens, but by increasing the distance between retina and lens through contraction of the ciliary muscle. This muscle is unstriped, and the rate of accommodation is slow.

Accommodation is altogether absent in frogs. In these, too, the curvature of the cornea is so great, that in water the hypermetropia, for which no correction exists, is as high as twenty-five diopters. Toads, which can more easily than frogs catch worms and near still objects, possess a slight power of accommodation.

Serpents accommodate in a similar manner, but quicker, because instead of a ciliary muscle, which is generally absent, they possess a striped circular muscle inserted in the attachment of the iris. Contraction thereof presses forward the lens, without altering its curvature, towards the cornea. This mechanism of accommodation increases the pressure in the posterior chamber, and is consequently destroyed by opening the latter.

Accommodation is in all such cases effected by *relaxation*, as originally asserted by Helmholtz, not by increased tension, of the suspensory structures of the lens. By this action it becomes more spherical and of shorter focus This change can be seen to have taken place in some animals even after removal of the supporting ligaments.

Of Amphibians many have a range of accommodation from ten to fifteen diopters. In animals of nocturnal habits accommodation is least developed. It is in birds that it reaches its highest perfection. Crampton's muscle is here the chief factor in producing relaxation, the inner layer of the cornea being pulled *back*, and not the parts behind the ciliary region forward, as in mammals, where the choroid is pulled forward.

It has been supposed that tightening the zonula caused increased pressure in the vitreous, and thereby increased the curvature of the front surface of the lens. Since, however, electrical stimulation of the enucleated cat- or monkey-eye produces nearly identical results, whether the bulb be intact or cut into (in the latter case there can be no increased pressure in the vitreous), this theory can hardly be correct.

Man has the greatest range of accommodation. After him come monkeys (up to ten diopters), then cats and other beasts of prey, and seals. Larger-eyed animals accommodate at a greater distance, but through a lesser range than man. Horses can also accommodate. But many animals, *e.g.* dog, use their noses rather than their eyes to examine near objects.

The anatomical investigations of Hess and Heine have confirmed most of these ophthalmosopic and experimental results.

Thus the two historical inventions of Helmholtz, the ophthalmometer and the ophthalmoscope, are invaluable not only to ophthalmology, but also to comparative physiology.

NOTES.

The first of the two annual soirées of the Royal Society will be held on Wednesday, May 3. This is the soirée to which gentlemen only are invited.

The Deputy-Master of the Trinity House, with a committee of Elder Brethren, accompanied by Lord Rayleigh, their scientific adviser, and Captain the Hon. F. C. P. Vereker, of the Board of Trade, arranged to leave London yesterday for Dover, with the object of making an official inspection of the wireless telegraphy system as experimentally in operation between the South Foreland lighthouse and the East Goodwin light vessel.

Reuter's correspondent at Buenos Ayres reports that despatches received from Punta Arenas, Patagonia, announce the arrival there of the *Belgica* with the members of the Belgian Antarctic Expedition, under the command of Lieutenant de Gerlache. The *Belgica* is said to have remained fast in the ice for two months.

Lord Rayleigh and Prof. G. H. Darwin have been elected honorary members of the New York Academy of Sciences.

Dr. T. J. J. See, who was recently appointed professor of mathematics in the U.S. Naval Observatory, has been nominated as chief of the American Nautical Almanac Office.

Prof. Milne-Edwards, director of the Paris Natural History Museum, and president of the Geographical Society, has received the Grand Cross of the Swedish Order of the Polar Star from King Oscar II.

Mr. J. Stanley Gardiner, Balfour student of the University of Cambridge, and Mr. L. Borradaile have gone to the Island of Minikoi, situated between the Maldive and Laccadive Islands, to study the formation of coral reefs with special reference to the depth at which the reef-building coral organisms live, the food of the coral polyps, the influence of currents upon coral formations and upon the distribution of life near them, and the inter-relationship existing between the various organisms which occur on a coral reef. It is also proposed to survey the Maldive Islands with a view to obtaining information as to their mode of formation. Mr. C. F. Cooper will join the expedition during the summer.

Sir John Lubbock, in a letter to Monday's *Times* on the Government Telephone Bill, draws attention to a point that is often lost sight of. He points out that if the telephone becomes national property, not only will the State lose money, but "the results as regards the progress of applied science will, in my judgment, be even more disastrous. Those who have hitherto devoted thought and time, energy and capital, to apply the results of scientific discovery to practical purposes are now told, that while, of course, if their enterprise does not pay, they must bear the loss, on the other hand, if it succeeds, Government will pass an Act of Parliament to deprive them of any advantage." In support of this opinion he quotes the late Mr. Varley as follows:—"The introduction of protectionism in so important an industry as telegraphy has given the postal executive a grip hold of applied electricity, and has enabled them to crush practically out of existence pioneers in telegraphy and applied electricity. English telegraph enterprise no longer exists, and America, which twenty years ago was electrically in the rear of this country, is now England's teacher. At the present time not only does she take premier rank in dynamo-electric developments, but practically all the telegraphic advances which have been made since the passage of the Telegraph Act have originated from American genius." . . . "The sole object I have in view in writing is to bring home to the British public, if I can, the evil consequences of the un-English retrograde policy of converting applied science into a Government trading monopoly." This point should engage the attention of the Society of Telegraph Engineers.

A few facts with regard to irrigation in India were mentioned by Lord Curzon on Monday, in replying to an address of welcome from the people of Lyallpur, a new town founded as a result of the Chenab irrigation scheme. The Viceroy pointed

out that four years ago Lyallpur, now a flourishing township and mart for agricultural produce, was a barren, uninhabited jungle. In six years 1,000,000 acres have been brought under cultivation at a capital outlay of 1,500,000*l.*, while the net revenue for the last year was 16 lakhs of rupees, or a return of nearly $7\frac{1}{2}$ per cent. of the capital expended. It is now estimated that the total value of the crops in a single year equals the capital cost of the entire works. At the present time in the Punjab alone 9500 miles of main and branch canals have been constructed, not including 10,500 miles of small distributaries. The total area irrigated by these means, which in 1868 amounted only to 1,000,000 acres, in 1878 to 1,300,000 acres, and in 1888 to 2,300,000 acres, has risen, owing to the startling progress of the last decade, to 5,200,000 acres. These figures form a striking testimony to British philanthropy, organising power, and engineering skill.

THE sixty-seventh annual meeting of the British Medical Association will be held at Portsmouth on August 1–4. The present President is Sir Thomas Grainger Stewart; and the President-elect is Dr. John Ward Cousins. An address in medicine will be delivered by Sir Richard Douglas Powell, Bart.; and an address in surgery will be delivered by Prof. Alexander Ogston. The scientific business of the meeting will be conducted in twelve sections—namely medicine, surgery, obstetrics and gynæcology, State medicine, psychology, anatomy and physiology, pathology, ophthalmology, diseases of children, pharmacology and therapeutics, laryngology and otology, and tropical diseases.

THE Liverpool Marine Biology Committee have arranged their usual Easter party for dredging and other zoological work at the Port Erin Biological Station. The station will be full of workers during not only the present week, but throughout April. In addition to members of the committee there are students from Liverpool, Manchester, Cardiff, Newnham and other colleges. The Lancashire Sea Fisheries steamer is at Port Erin, and several days will be spent in trawling and tow-netting in the deep water between the Isle of Man and Ireland. A long hose-pipe and pump will be used for obtaining plankton from the bottom waters, and a closing tow-net will also be tried. Another section of the work consists in the collection of fish spawn for the Lancashire hatchery. The hatching boxes at present contain over four million developing embryos of plaice and cod.

IN view of the visit of the British Association to Glasgow in 1901, an effort is being made to draw up complete lists of the fauna, flora, and geological features of the Clyde district. A natural history sub-committee has been formed, the Convener being Prof. John Young; Vice-Convener, Prof. Malcolm Laurie; and Secretary, Rev. G. A. Frank Knight, Almanarre, Garelochhead. A leaflet, showing the scheme of work that has been sketched out, has been prepared with the hope of obtaining help from various quarters to assist the different compilers in their labours. Information is specially desired as to (1) distribution of species; (2) papers in magazines, journals, and transactions of societies, which might otherwise be overlooked; and (3) names of workers in the different departments who might be willing to assist. The scope of the inquiry, as arranged by the committee, is "the natural drainage area of the Clyde, and of all the sea lochs which form extensions of its estuary." The northern limit, therefore, is the watershed beyond the head of Loch Fyne, and the southern boundary has been defined as a line drawn between the Mull of Cantire and the most southerly point of Ayrshire. Further information can be obtained from the Secretary.

WE learn that some recognition will shortly be made of the invaluable services rendered to geological science by the Rev. Thomas Wiltshire, Professor Emeritus of Geology in King's College, London. Of late years Mr. Wiltshire's labours have not been of a nature to bring his name prominently before the public, but he has been toiling quietly as the honorary secretary and editor of the Palæontographical Society. That Society has now published fifty-two quarto annual volumes, and some thirty of these have, we believe, been edited by Mr. Wiltshire. These volumes each contain forty or fifty plates of fossils, and two hundred or more pages of letter-press, dealing with organic remains of all classes. The interest attaching to these volumes is world-wide, and so is their reputation. Immense credit is undoubtedly due to Mr. Wiltshire, and it is pleasing to learn that the members of the Palæontographical Society (of whom Dr. Henry Woodward, F.R.S., is president, and Mr. R. Etheridge, F.R.S., treasurer) have decided to present him with a testimonial, towards which subscriptions (not limited to members of the Society) are now being received.

A FEW particulars as to the progress which is being made by the Royal Commission on Sewage Disposal are given in the *Lancet*. It is stated that, in addition to hearing evidence and visiting a number of sewage works, the Commission have been engaged in determining a number of important questions relating to the desirability or not of laying down chemical and bacteriological standards which should be obtained by effluents, whether in the case of domestic sewage only or of such sewage combined with trade refuse. For this purpose they have employed experts of their own, and it is understood that the staff of chemists and bacteriologists has just been increased, so that the effluents from works of different character can be systematically studied, almost hourly by day and by night, under varying conditions of temperature and rainfall. No statement can as yet be made as to the term over which these experiments must extend; but it is quite clear that they are at present only in an initial stage, and that, in so far as bacteriological results are concerned, the Commission are dealing with a subject as to which little expert evidence is available, and that the matter will have to be examined very deliberately and exhaustively before useful inferences can be drawn. These experiments are being carried out under the supervision of a committee of the Royal Commission, consisting of Sir Richard Thorne, F.R.S., Prof. Michael Foster, F.R.S., and Prof. Ramsay, F.R.S.

A PAPER, by Mr. W. C. Peckham, in the April number of the *Century*, on the liquefaction of gases in general, and the work of Prof. Dewar and Mr. Charles E. Tripler, of New York, in particular, contains some remarkable pictures of experiments with liquid air. The method used by Mr. Tripler to liquefy air is the same as that employed by Dr. Linde and Dr. Hampson. Air is compressed to between two thousand and three thousand pounds per square inch, and cooled by water flowing round the pipes containing it. As it escapes it expands, and is therefore cooled, and this colder air is made to pass around the pipes so as to reduce the temperature of the air in them. The result of this self-intensification is a continual reduction of temperature within the pipes until the temperature of liquefaction, -312° Fahr., is reached. A laboratory form of this apparatus produces from thirty to forty gallons of liquid air in ten hours. In fifteen minutes after the engine is started liquid air can be drawn off. A number of experiments, many of which exemplify results obtained by Prof. Dewar, are described and illustrated in the article. One of the most striking experiments is performed by placing over a cool fire a tea-kettle containing some liquid air. "The heat of the fire evaporates the liquid, and a stream of vapour of air shoots out of the spout to a great height. It looks like steam from a kettle of boiling water. In a very short time water poured into the kettle may be taken out as ice, and the bottom

of the kettle is found to be coated with solid carbonic acid frozen from the fire, which glows intensely a hand's breadth away. Yet liquid air will boil with apparently the same violence if set upon a cake of ice." Popular knowledge of the phenomena of liquid air in America is due almost entirely to Mr. Tripler, whose experiments with gallons of liquefied air have excited considerable interest.

The remarkable discoveries, made in the first place by Japanese botanists, respecting the mode of fertilisation in Gymnosperms, have been followed up by two further papers published in the *Journal of the College of Science* of Tokyo (vol. xii., parts 2 and 3). Prof. Hirasé gives (in French) a further contribution to our knowledge of the impregnation and biology of *Gingko biloba* (*Salisburia adiantifolia*); and Prof. Ikeno (in German) a further account of the development of the sexual organs and the process of impregnation in *Cycas revoluta*. The mature pollen-grain of *Gingko* consists of three cells of unequal size; the largest is the vegetative cell; a small intermediate cell is the antheridial cell; the smallest exterior cell is inactive. From the largest of these cells is produced the pollen-tube, which branches and spreads over the surface of the nucellus. The intermediate cell divides into a body-cell and a stalk-cell; the contents of the body-cell again divide into two antherozoids, their formation being accompanied by the appearance of attraction-spheres. In the formation of the archegone of *Cycas* three periods may be distinguished—the "primordium" (*Anlage*) period, the period of growth, and that of maturity. The pollen-grain consists of two small prothallium cells and a large embryonal cell. Shortly after pollination the pollen-grain produces a tube. The inner prothallium-cell divides into a body-cell and a stalk-cell: in the former appear two centrosomes. Shortly before impregnation the nucleus of the body-cell, or spermatogenous cell, divides into two nuclei, and the cell itself into two spermatids. The nucleus of each spermatid forms an antherozoid, with a nucleus, and a tail composed of cytoplasm. In the nucleus of the oosphere is a crater-like cavity, which the antherozoid enters, in order to fuse with the nucleus of the oosphere.

From a paper by Mr. E. S. Salmon on the genus *Fissidens* in the *Annals of Botany*, we learn that the following is the geographical distribution of this genus of mosses, the first number in each case being the total number of species, and the second the number of endemic species:—Europe, 32, 13; Asia, 92, 84; Africa, 159, 140; North America, 74, 49; South America, 118, 106; Pacific, 60, 50.

We learn from the Allahabad *Pioneer Mail* that Dr. Stein. the learned Principal of the Oriental College at Lahore, has published, through the Punjab Government Press, a detailed report of the results of his examination of the archæological remains in Buner. Dr. Stein accompanied Sir Bindon Blood's force in the expedition to the Buner country in December 1897, and had a unique opportunity of investigating the ruins, rock sculptures, and inscriptions of a portion of the ancient Udyana which had previously been inaccessible to scholars. The monograph is certain to be read with great interest by archæologists both in India and in Europe.

Some interesting statistics with reference to the seal and whale fishery in 1898 are given by Mr. Thomas Southwell in the *Zoologist* for March. The total number of seals taken by the fleet of eighteen steamers, of the aggregate capacity of 5595 tons, and manned by 3802 seamen, which left St. John's, Newfoundland, in March 1898, for the Gulf fishery grounds, was 241,708, of a net value of about 80,000*l.*, as compared with 126,628, valued at 32,564*l.*, in the previous season. In addition to these, about 30,000 seals were taken by the sailing vessels and by the shore fishermen. Mr. Southwell states that the seal fishery in the Greenland seas, so far as the Dundee vessels are concerned, has practically become a thing of the past, and, such as it is, has almost drifted into the hands of the Norwegian vessels. Right whales were extremely scarce during the season; the absence of the whales from Greenland seas being attributed to fine weather and light ice. The bottle-nose whale fishery, which was once so productive, is now quite discarded by the British vessels. The total catch of the Dundee fleet in 1898 was 6 right whales, 984 white whales, 591 walrus, 779 seals, and 80 bears, yielding 297 tons of oil and 112 cwts. of bone.

The United States Department of Agriculture has recently been devoting a good deal of attention to dietary studies amongst the poor in different parts of the country, and the Office of Experimental Stations has already issued quite a number of different bulletins on this subject. The most recent addition to the series is one on dietary studies in Chicago in 1895 and 1896. To obtain satisfactory statistics on this subject is by no means easy, for the data sought include the character, amount, and cost of food consumed during a given length of time, the age, sex. and occupation of the different members of the various families selected, the number of meals taken by each person, and, as far as possible, the financial and hygienic conditions of the family in question. To facilitate the conduct of an inquiry of so personal a nature, two ladies from the Hull Settlement, which is situated in a densely-populated district of Chicago, were asked, on account of their intimate acquaintance with the neighbourhood and inhabitants, to collect the information required. Families of Italians, French Canadians, Russian Jews (both orthodox and unorthodox), and Bohemians were chosen; whilst for comparison three American families were also included: in all, about fifty studies were carried through more or less satisfactorily. National prejudices and idiosyncrasies render living for foreigners more expensive in many instances than for natives, as, for example, is the case with Italians, who cannot be persuaded to exchange the imported oil, wine, and cheese for the far less costly food to be obtained in American cities. The result of the inquiry emphasises the need for education among the poorer classes, both in household management and cookery, and also in the selection of foods. Taste and cost are usually the only considerations to which attention is paid; the fact that foods vary greatly in nutritive value is rarely, if ever, recognised. In many cases families could obtain a more nutritious diet for the sum expended, or an equally nutritious diet for a smaller sum.

We have received from Profs. A. Riccò and G. Saya a copy of the results of hourly simultaneous meteorological observations made at four stations between the Observatory at Catania (altitude 65 metres) and the Etna Observatory (altitude 2947 metres): the heights of the intermediate stations being respectively 705 and 1886 metres. The observations were only made on July 26-28, 1897, and March 27 and 28, 1898, so that we shall merely refer briefly to one or two of the general results. In July the diminution of temperature, with respect to altitude, was less between the two lower stations than between the upper ones; while in March the diminution was somewhat less, and much more uniform. In July the relative humidity decreased between the first and third stations, but increased between the third and fourth. In March there was scarcely any decrease between the first and second stations, and a considerable increase between the second and fourth stations. The same authors have sent us a copy of the results of observations of air and sea temperature, and of the colour of the water, in the Adriatic and Ionian Seas. The maximum temperatures, especially of the surface water, are nearly equal in

the two seas, but the minima of the Adriatic are much lower than those of the Ionian Sea. These results are based upon observations made during one year.

MR. J. BAXENDELL has sent us a copy of the report of the Fernley Observatory, Southport, for the year 1898. The observatory is maintained by the corporation of that town, and is one of the best equipped in the United Kingdom. Observations have been regularly taken at Southport for nearly thirty years, having been commenced by the late Mr. J. Baxendell (father of the present observer), who was a meteorologist of considerable repute. The results, it is almost unnecessary to say, show evidence of very careful work, and include, in addition to the usual elements, observations of sea-surface and underground temperature, evaporation, ozone, &c., and a useful table, containing comparisons with other health resorts, is appended to the report. All such stations vie with each other in giving good reports of bright sunshine. Southport possesses both the Campbell-Stokes burning recorder and the Jordan photographic recorder, and we are glad to see that the records of the latter are "fixed" before being measured. Possibly this is not done at all stations; when measured before "fixing" the results are somewhat exaggerated, as compared with those of the burning recorder. We should scarcely have expected the sunshine at Guernsey (where a photographic recorder is used) to have been greater than at Jersey.

WE have received together the 13th and 14th reports of the State Entomologist of the State of New York for 1897 and 1898, on "Injurious and other Insects." The report for 1897, which was edited by the late Dr. J. A. Lintner, calls attention to the decline in the spread of the formidable San José scale, and deals briefly with a large number of insects, some few being noticed at greater length. The two plates represent *Tenthredo rufopectus*, Norton, and three species of *Uroceridae*, and the spines of the larva of *Eacles imperialis*, Drury (after Packard). The report for 1898 is edited by Dr. Ephraim Porter Felt, Acting State Entomologist. During that year much damage was caused to trees in America by the attacks of various caterpillars. The general character of this report is similar to that of the last; both are illustrated with woodcuts in addition to the plates, and both contain useful bibliographical notices relating to various insects discussed. The report for 1898 contains nine plates, several of which are devoted to illustrations of trees defoliated by caterpillars to an extent fortunately not often seen in Europe. The other plates illustrate various moths, caterpillars, *Coccidae*, and the cast skin of a *Tarantula*.

THE seventh volume of the *Annalen der Sternwarte in Leiden*, published by the director of the observatory, Prof. H. G. van de Sande Bakhuyzen, contains four contributions, three of which, as we are told, have been previously distributed among some observatories. The first of these, by the director himself, is devoted to investigations on the period of rotation of the planet Mars, and to variations of his spots. The author has made use of all the available data, and finds that in Schrœter's and Herschel's time a very dark spot, similar in form to that of Syrtis Major, but fifty to fifty-five degrees distant from the latter, was situated in the region of Cyclopium. This, he says, indicates large variations in this part of Mars' surface. He is also led to adopt new values for the time of transit of the zero of longitude and the period of rotation, this value for the latter being 24h. 27m. 22·66s., with a mean error of ± 0·0132s. The second paper, also by himself, gives an account of an apparatus he has devised for determining the absolute personal equation of an observer in making transit observations. The chief part of the apparatus consists of a movable and fixed prism, the velocity of the former being known. By a simple arrangement of mirrors, the artificial star can be viewed in the transit instrument when the latter is set at any altitude. Prof. J. C. Kapteyn is the author of the third memoir, which deals with the determination of the parallaxes with the meridian circle; while the last paper contains the determination of the difference of longitude between Leyden and Greenwich, by Prof. H. G. van de Sande Bakhuyzen and his brother, Dr. E. F. van de Sande Bakhuyzen; the final value adopted for the difference of longitude being given as 17m. 55·891s.

MESSRS. DULAU AND CO. have issued a catalogue of book and papers on astronomy and meteorology offered for sale by them.

THE twenty-ninth volume of the *Proceedings* of the London Mathematical Society has just been published in two parts. The volume contains papers read before the Society from November 1897 to November 1898; but as brief abstracts of these papers have appeared in our reports of Societies, it is unnecessary to do more now than announce their publication in a complete form.

THE fifteenth edition of Kirkes' well-known "Handbook of Physiology," by Prof. W. D. Halliburton, F.R.S., has just been published by Mr. John Murray. The results of important researches in all branches of physiology have been incorporated, and the order in which the subjects are treated has been modified, the section on the central nervous system being now placed towards the end of the book. The additions and alterations will increase the value of the volume to teachers and students.—A second edition of "Chemistry for Photographers," by Mr. C. F. Townsend, has been published by Messrs. Dawbarn and Ward, Ltd.

THE additions to the Zoological Society's Gardens during the past week include a Bay-thighed Monkey (*Cercopithecus ignatus*, ♂), a Green Monkey (*Cercopithecus callitrichus*) from Liberia, presented by Mr. J. F. Braham; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Captain F. E. Bishop; a Cape Jumping Hare (*Pedetes caffer*) from South Africa, presented by Mr. W. Champion; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. S. Humble; a Pel's Owl (*Scotopelia peli*) from West Africa, presented by Lieut. E. V. Turner, R.E.; two Ravens (*Corvus corax*), European, presented by Mr. Francis Walpole; a Giraffe (*Giraffa camelopardalis*, ♂) from South-east Africa, two Elands (*Orias canna*, ♂ ♀) from the Transvaal, a Bless-bok (*Damaliscus albifrons*, ♂) from South Africa, deposited; a Red-faced Ouakari (*Ouacaria rubicunda*, ♀) from the Upper Amazons, a Naked-throated Bell-bird (*Chasmorhynchus nudicollis*), three Blue-bearded Jays (*Cyanocorax cyanopogan*) from Brazil, purchased.

OUR ASTRONOMICAL COLUMN.

TUTTLE'S COMET (1899 *b*).—

Ephemeris for 12h. Berlin M.T.

1899.	R.A. h. m. s.	Decl. ° ′ ″	Br.
April 6	3 0 50·6	+26 25 6	0·96
8	8 21·0	25 47 8	1·02
10	15 49·8	25 7 48	
12	23 16·7	24 27 7	1·07
14	30 41·4	23 45 6	
16	38 3·9	23 1 44	1·12
18	45 24·2	22 17 1	
20	52 42·1	21 31 0	1·18
22	3 59 57·3	20 43 43	
24	4 7 10·0	19 55 12	1·23
26	14 20·2	19 5 30	
28	21 28·0	18 14 38	1·28
30	4 28 33·2	+17 22 40	

The comet is increasing in brightness, and is moving in a south-easterly direction through Aries and Taurus. On the 17th it passes close to the Pleiades, and on the 30th it is close to α Tauri (Aldebaran). A telegram from Herr Wolf, of Heidelberg, states that the comet is about the 11th magnitude (*Ast. Nach.*, Bd. 148, No. 3552).

Meteor Observations from a Balloon.—The March number of the *Bull. de la Soc. Astr. de France* contains an article by M. A. Hansky, of the Meudon Observatory, describing his attempt to observe the Leonid meteor shower in November 1898 from a balloon. The experiment was so far successful in that the observers saw a number of meteors, the sky to them being perfectly clear, although to the people on *terra firma* in Paris the sky was completely clouded over. This was at a height of only about 150 metres. Attention is also drawn to the other astronomical observations which might be made in this way when otherwise impossible on account of local weather conditions Among these may be mentioned the observation of solar and lunar eclipses, the zodiacal light, the gegenschein, and auroræ, which last are probably very frequent but masked by atmospheric glare or insufficient transparency of the air at low levels.

The first balloon ascent for astronomical purposes, so far as is known, was made by the Russian chemist Prof. Mendeléef, who, by this means, was enabled to observe the total eclipse of the sun in 1867.

Planetary Perturbations.—In *Ast. Nach.*, Bd. 148, No. 3549, Prof. S. Newcomb draws attention to a source of error in the formulæ used in computing the positions of the planets at future or past epochs. In the method of "special perturbations," which is often used, a small error in the decimal places, arising from superfluous numbers or uncertainty in the data is, from the nature of the integrals, accumulative with the *time*. Prof. Newcomb takes integrals of the various types commonly used, and shows the relative errors introduced in their evaluation. The mean longitude, requiring two integrations for its determination, will have a more rapidly accumulating error than the other elements, and hence its computation should be done with special care.

U.S. Naval Observatory.—We have just received the report of the superintendent of the Naval Observatory for the fiscal year ending June 30, 1898, embodying the several reports made by the directors of the various departments.

The 26-inch refractor has almost exclusively been used on faint and difficult objects, including observations of D'Arrest's and Giacobini's comets; measures of Titan and Japetus for a new determination of the mass of Saturn (1 : 3491·8), this appearing to be affected by the different brightness of the two, so new measures of Rhea and Japetus are to be made; forty-one complete measures of position angle and distance of Neptune's satellite were obtained, and the diameters of Mercury and Venus on all possible occasions.

Some interesting experiments were made to spectroscopically determine the *colour curve* of the 26-inch. The minimum focal length occurs about E, from which the focal plane for F is 0·142 inches, and for G (iron) 1 233 inches distant.

The 12-inch has been used in observing comets, minor planets, occultation of stars, and eclipses of Jupiter's satellites. In past years this instrument has been used for the exhibition of celestial objects to the public on two evenings each week; this has now been limited to one evening. The number of visitors during the year has been nearly 1500.

Two new instruments have been acquired, a 6-inch transit circle and a 5-inch altazimuth, both marking a new departure in being made entirely of steel, in the endeavour to reduce to a minimum the changes due to flexure and temperature. Both instruments have been made by an American firm, this choice being seemingly justified by their performance after installation.

The new tables of the planets Mars, Uranus and Neptune are nearly completed ready for publication.

The department of nautical instruments, chronometers and watches was under a great strain during the war with Spain, all available instruments in the country being purchased, and many having to be sent out without the complete tests usually applied before acceptance.

The magnetic department is likely to be abandoned owing to the serious disturbing effects of the currents leaking from the numerous electric plants in the immediate vicinity.

ALLOYS OF IRON AND NICKEL.

At the Institution of Civil Engineers, on March 28, a paper was read on "Alloys of Iron and Nickel," by Mr. R. A. Hadfield. The effect upon iron of gradually increasing amounts of certain added foreign elements has already been investigated by Mr. Hadfield in experiments upon the mechanical and physical properties of alloys of iron and manganese, silicon, aluminium and chromium, both in the cast and forged conditions. The present paper contains the results of a similar investigation of the alloys of iron and nickel. The addition of nickel, either by conferring greater homogeneity or by some particular combination with the iron or carbon present, or both, appears to confer properties upon the alloy equivalent to an annealing, or, if annealing be employed, to reduce the stress produced by forging; it does this even in the annealed material without injuring or seriously lowering the elastic limit. In this respect, therefore, its presence is of considerable practical utility. It would appear there is considerable room for improving the material of propeller-shafts. The well-known Russian metallurgist, Chernoff, has stated that steel is composed of crystals of metallic iron cemented by carbide of iron, the result being that in the case of nickel-iron alloys the inter-crystalline spaces (a subject which has been fully and carefully investigated by Mr. T. Andrews, F.R.S., as regards ordinary steel) are much more completely filled, and the cohesion consequently rendered more powerful. The points of solidification of the cement and crystals are nearer, thus producing or maintaining a more intimate interweaving of the elements. In support of this theory may be cited the fact that without doubt nickel-iron alloys show less tendency to segregation, which apparently indicates that the combinations formed at high temperature are more intimately maintained when the alloy cools and becomes solidified than is the case with ordinary steel. That scientific evolution disregards nationalities is well illustrated in the case of the metal nickel and its developments. The Swedish chemist Cronstedt, at work in his laboratory, conceived the idea that the deceptive Kupfer-Nickel is a metal containing a new element; from him it passed to other Swedish investigators, thence to those of German, French, and other nationalities. Attempts were made by Faraday to artificially produce meteoric iron; similar efforts were afterwards made in France, Germany and elsewhere. Apparently a period of inactivity followed, during which, however, first one and then another experimenter added facts to the general stock. Finally, as regards the metallurgy of nickel as applied to iron and steel, Marbeau, in France, applied the matter experimentally; Schneider, in France, perfected its application to a number of purposes, chiefly armour-plates; Riley brought the manufacture to a practical issue in England; American and Canadian enterprise followed in the perfecting of cheaper methods of producing nickel, and a new product—nickel steel—appeared. It has taken about 125 years to arrive at the stage reached to-day. No one person, no one nationality, can lay claim to its discovery, to its inception. If a chart were constructed on genealogical lines, how much would be seen to have sprung from the laboratory experiments by Cronstedt? But, if it were possible, long before the work of the Swede would be discovered the early workers of the old world in China and Japan, about whose work dates and facts were inaccessible. Apparently, to modern ideas, mention of nickel appears to have struggled into existence between the years 1600 and 1700, but the metal must have been well known, not merely centuries, but almost thousands of years earlier.

THE PRESENT STATE OF EVOLUTION.[1]

Only a little less than fifty years have passed since the publication of Darwin's "Origin of Species," and the general acceptance by naturalists of the theory of descent. Since 1848 the sciences of embryology, cytology, and comparative anatomy based on embryology—or, as it is now called, morphology—have been placed on a firm foundation. It is but little over half a century since the uniformitarian views of Lyell were promulgated. The cell doctrine was born in 1839; the view that pro-

[1] Prologue of an address entitled "A Half-Century of Evolution, with special reference to the Effect of Geological Changes on Animal Life," delivered by Prof. Alpheus S. Packard before the Section of Zoology of the American Association for the Advancement of Science at the Boston meeting (fiftieth anniversary) on August 22, 1898.

toplasm forms the basis of life was generally received forty years since; fifty years ago the doctrine of the conservation of forces was worked out, and already by this time had the idea of the unity of nature dominated the world of science.

On the fiftieth anniversary, therefore, of our Association, it may not be out of place, during the hour before us, first, briefly to inquire into the present state of evolution and its usefulness to zoologists as a working theory, and then to dwell more at length on the subject of the effect of geological changes on animal life.

The two leading problems which confront us as zoologists are: What is life? and, How did living beings originate? We must leave to coming centuries the solution of the first question, if it can ever be solved; but we can, as regards the second, congratulate ourselves that—thanks to Lamarck, Darwin, and others, in our day and generation—a reasonable and generally accepted solution has been reached.

Time will not allow us to attempt to review the discoveries and opinions which have already been discussed by the founders and leaders of the different schools of evolutionary thought, and which have become the common property of biologists, and are rapidly permeating the world's literature.

It may be observed at the outset that, if there is any single feature which differentiates the second from the first half of this century, it is the general acceptance of the truth of epigenetic evolution as opposed to the preformation or incasement theory, which lingered on and survived until a late date in the first half of the present century.[1] The establishment of the epigenetic view is largely due to exact investigation and modern methods of research, but more especially to the results of modern embryology and to the fairly well digested facts we now have relating to the development of one or more types of each class of the animal kingdom.

To use a current phrase, the evolution theory is now held as come to stay. It is the one indispensable instrument on which the biologist must rely in doing his work. It is now almost an axiomatic truth that evolution is the leaven which has leavened the whole lump of human intellectual activity. It is not too much to claim that evolutionary views, the study of origins, of the beginning of organic life, the genesis of mental phenomena, of social institutions, of the cultural stages of different peoples, and of their art, philosophy, and religion—that this method of natural science has transformed and illuminated the philosophy of the present half-century.[1]

It is naturally a matter of satisfaction and pride to us as zoologists that, though evolution has been in the air from the days of the Greek philosophers down to the time of Lamarck, the modern views as to the origin of variations, of adaptation, of the struggle for existence, of competition, and the preservation of favoured organs or species by selection are the products of single-minded zoologists like Darwin, Wallace, Fritz Müller, Semper, and Haeckel. It is the work of these men, supplemented by the labours of Spencer and of Huxley, and the powerful influence of the botanists, Hooker and Gray, all of whom contributed their life-long toil and efforts in laying the foundation-stones of the theory, which has brought about its general acceptance among thinking men. It is these naturalists, some of them happily still living, who have worked out the principle of evolution from the generalised to the specialised, from the simple to the complex, from chaos to cosmos.

The doctrine of evolution has been firmly established on a scientific basis by many workers in all departments of biology, and found not only to withstand criticism from every quarter, but to be an indispensable tool for the investigator. The strongest proof of its genuine value as a working theory is that it has, under the light shed by it, opened up many an avenue of inquiry leading into new fields of research. It is based on the inductive method, the observation and arrangement of a wide series of facts. Moreover it explains a vast complex of facts, and enables us to make predictions, the true test of a scientific theory. Biology is not an exact science, hence the theory is not capable of demonstration like a problem in mathematics, but is based on probabilities, the circumstantial evidence being apparently convincing to every candid, well-trained mind.

The methods and results of natural science, based as they now are on evolutional grounds, have, likewise, appealed to the historian, the philologist, the sociologist, and the student of comparative religion, whose labours begin with investigations into the origins.

It goes without saying that, thanks to the initiative of the above-named zoologists, every department of intellectual work and thought has been rejuvenated and rehabilitated by the employment of the modern scientific method. All inquiring minds appreciate the fact that, throughout the whole realm of nature, inorganic as well as organic, physical, mental, moral and spiritual, there was once a beginning, and that from a germ, by a gradual process of differentiation or specialisation, the complex fabric of creation has, by the operation of natural laws and forces, been brought into being. All progress is dependent on this evolutionary principle, which involves variation, adaptation, the disuse or rejection of the unfit, the use or survival of the fittest, together with the mechanical principle of the utmost economy of material.

Though the human mind has its limitations, and the chief arguments for evolution have been drawn from our observations of the history of our own planet, and of the life existing upon it, the nebular hypothesis teaches us that the same process has determined the origin of other worlds than ours, and applies in fact to all the other members of our solar system, while with little doubt the principle may be extended to the entire universe.

At all events evolutionary modes of thinking have now become a second nature with philosophic, synthetic minds, and to such any other view is inconceivable. We teach evolution in our colleges and universities, and the time is rapidly approaching, and in some instances has already come, when nature-

[1] The theory of incasement (*emboitment*), propounded by Swammerdam in 1733, was that the form of the larva, pupa and imago of the insects pre-existed in the egg, and even in the ovary; and that the insects in these stages were distinct animals contained one inside the other, like a nest of boxes, or a series of envelopes, one within the other; or, in his own words: "*Animal in animali, seu papilio intra erucam reconditus.*" Réamur (1734) also believed that the caterpillar contained the form of the chrysalis and butterfly, saying: "Les parties des papillon cachées sous le fourreau de chenille sont d'autant plus faciles à trouver que la transformation est plus proche. Elles y sont neanmoins de tout temps." He also believed in the simultaneous existence of two distinct beings in the insect. "Il serait très curieux de connaitre toutes les communications intimes qui sont entre la chenille et le papillon . . . La chenille hache, broye, digere les aliments qu'elle distribué au papillon; comme les mères préparent ceux qui sont ports aux fœtus. Notre chenille en un mot est destinée à nourrir et à defendre le papillon qu'elle renferme" (Tome i, 8e Mémoire, p. 363).

It was not until 1815 that Herold exploded this error, though Kirby and Spence in 1828, in their "Introduction to Entomology," combated Herold's views, and maintained that Swammerdam was right. As late as 1834, a century after Swammerdam Lacordaire in his "Introduction à l'Entomologie," declared that "a caterpillar is not a simple animal, but compound," and he actually goes so far as to say that "a caterpillar, at first scarcely as large as a bit of thread, contains its own teguments threefold and even eightfold in number, besides the case of a chrysalis, and a complete butterfly, all lying one inside the other." This view, however, we find is not original with Lacordaire, but was borrowed from Kirby and Spence without acknowledgment. These authors, in their "Introduction to Entomology" (1828), combated Herold's views, and stoutly maintained the old opinions of Swammerdam. They based their opinions on the fact, then known, that certain parts of the imago occur in the caterpillar. On the other hand, Herold denied that the successive skins of the pupa and imago existed as germs, holding that they are formed successively from the "*rete mucosum*," which we suppose to be the hypodermis of later authors. In a slight degree the Swammerdam-Kirby and Spence doctrine was correct, as the imago does arise from germs, *i.e.* the imaginal discs of Weismann, while this was not discovered by Herold, though they do at the outset arise from the hypodermis, his *rete mucosum*. Thus there was a grain of truth in the Swammerdam-Kirby and Spence doctrine, and also a mixture of truth and error in the opinions of Herold.

The discovery by Weismann of the imaginal discs or buds of the imago in the maggot of the fly, and his theory of histolysis, or of the more or less complete destruction of the larval organs by a gradual process, and his observation of the process of building up of the body of the imago from the previously latent larval buds, was one of the triumphs of modern biology. It is therefore not a little strange to see him at the present day advocating a return to the preformation views of the last century in the matter of heredity. Of course it goes without saying, as has always been recognised, that there is something in the constitution of one egg which predestines its becoming an insect, and in that of another, which destines it to produce a chick.

[1] It is worthy of mention that just fifty years ago, in his "Future of Science," written in 1848, at the age of twenty-five, Renan, who first among philosophers and students of comparative philology adopted the scientific method, *i.e.* the patient investigation of as wide a range of facts as possible, wrote: "I am convinced that there is a science of the origins of mankind, and that it will be constructed one day, not by abstract speculation, but by scientific researches. What human life in the actual condition of science would suffice to explore all the sides of this single problem? And still, how can it be resolved without the scientific study of the positive data? And if it be not resolved, how can we say that we know man and mankind? He who would contribute to the solution of this problem, even by a very imperfect essay, would do more for philosophy than by half a century of metaphysical meditation" (p. 150). Again he says: "The great progress of modern thought has been the substitution of the category of *evolution* for the category of the '*being*,' of the conception of the relative for the conception of the absolute, of movement for immobility. Formerly everything was considered as 'being' (an accomplished fact); people spoke of law, of religion, of politics, of poetry in an absolute fashion. At present everything is considered as in the process of formation" (p. 169).

studies, and the facts of biology forming the grounds of the evolutionary idea, will be taught in our primary and secondary schools.

The rapidity with which evolutionary conceptions have taken root and spread may be compared to the rankness of growth of a prepotent plant or animal on being introduced into a new territory where it is free from competition. It has indeed swept everything before it, occupying a field of thought which hitherto had been unworked by human intelligence.

The immediate effect and a very happy one, of the acceptance of the theory of descent on working zoologists, is to broaden their minds. Collectors of insects and shells, or of birds and mammals, instead of being content simply to acquire specimens for their cabinets, are led to look during their field excursions for examples of protective mimicry, or to notice facts bearing on the immediate cause of variation. Instead of a single pair of specimens, it is now realised that hundreds and even thousands collected from stations and habitats wide apart are none too many for the study of variation as now pursued.

The race of "species grinders" is diminishing, and the study of geographical distribution, based as it is on past geographical changes and extinctions, is now discussed in a far more philosophical way than in the past. The most special results of work in cytology and morphology are now affording material for broad work in phylogeny and heredity.

On the other hand it must be confessed that, as the result of the acceptance of evolutionary views, our literature is at times flooded with more or less unsound hypotheses, some tedious verbiage and long-winded, aerial discussions, based rather on assumptions than on facts. But on the whole, perhaps, this is a healthy sign. Too free, exuberant growths will be in the long run lopped off by criticism.

One tendency should be avoided by younger students, that of too early specialisation, and of empirical work without a broad survey of the whole field. In some cases our histologists and morphologists rise little above the intellectual level of species describers. Expert in the use of the microtome and of reagents, they appear to have but little more general scientific or literary culture than high-class mechanics The chief antidote, however, to the danger of narrowness is the lessons derived from evolutionary thought and principles.

Finally, as a proof of the value of evolutionary ideas to the present generation, let us suppose for a moment, if it were conceivable, that they should be blotted out. The result, it is safe to say, would be equivalent to the loss of a sense.

It is a matter of history that when a new idea or principle or a new movement in philosophy or religion arises, it at first develops along the line of least resistance; the leaders of the new thought acquire many followers or disciples. Soon the latter outstrip their teachers, and go to greater extremes; modifications of the original simple condition or theory occur, and as the final result there arise schisms and differentiations into new sects. This has happened in science, and already we have evolutionists divided into Lamarckians and Darwinians, with a further subdivision of them into Neolamarckians and Neodarwinians, while the latter are often denominated Weismannians. Some prefer to rely on the action of the primary factors of evolution, others believe that Natural Selection embraces all the necessary factors, while still others are thoroughly persuaded of its inadequacy.

The result of this analytical or differentiating process will probably be an ultimate synthesis, a belief that there is a complex of factors at work. Of these factors those originally indicated by Lamarck, with the supplementary ones of competition and natural selection bequeathed by Darwin, are the most essential and indispensable, and it is difficult to see how they can be displaced by other views. Meanwhile all agree, and it was never more firmly established than at this moment, that there is and always has been unceasing energy, movement, and variation, a wonderful adaptation and harmony in nature, between living beings and their surroundings.

The present status of evolution in its different phases or attitudes since the time of the appearance of Darwin's "Origin of Species" may be roughly pointed out as follows:—

(1) The claim by some thinkers of the inadequacy of Darwinism, as such, or Natural Selection, to account for the rise of new species, and the assignment of this factor to what they believe to be its proper place among the other factors of organic evolution.

(2) The renaiscence of Lamarckism under the name of Neolamarckism, being Lamarckism in its modern form. This school relies on the primary factors of evolution, on changes in the environment, such as the agency of the air, light, heat, cold, changes in climate, use and disuse, isolation, and parasitism, while it regards natural, sexual, physiological, germinal and organic selection, competition or its absence, and the inheritance of characters acquired during the lifetime of the individual, as secondary factors, calling into question the adequacy of natural selection as an initial factor.

(3) The rise of the Neodarwinian school. While Darwin, soon after the publication of the "Origin of Species" somewhat changed his views as to the adequacy of natural selection, and favoured changes in the surroundings, food, &c., as causes of variation, his successors, Wallace, Weismann, and others believe in the "all-sufficiency" of natural selection. Weismann also invokes panmixia, or the absence of natural selection, as an important factor; also amixia, and denies the principle of inheritance of acquired characters, or use-inheritance.

(4) A third school or sect has arisen under the leadership of Weismann, who advocates what is in its essence apparently a revival of the exploded preformation, encasement, or "evolution" theory of Swammerdam, Bonnet and Haller, as opposed to the epigenetic evolutionism of Harvey, Wolff, Baer, and the majority of modern embryologists. On the other hand, there are some embryologists who appear to accept the combined action of epigenesis and evolution in development.

(5) Attention has been concentrated on the study of variations and of their cause. Opinion is divided as to whether variation is fortuitous or definite and determined. Many now take exception to the view, originally held by Darwin, that variations are purposeless and fortuitous, believing that they are, for example, dependent on changes in the environment which were determined in early geological periods. For definite variation Eimer proposes the term orthogenesis. Minute variations dependent on climatic and other obscure and not readily appreciable causes are now brought out clearly by a system of varied and careful quantitative measurements.

(6) More attention than formerly is given to the study of dynamical evolution, or kinetogenesis; to the effect of external stimuli, such as intermittent pressure, mechanical stresses and tensions by the muscles, &c., on hard parts. Originally suggested by Herbert Spencer, that the ultimate cause or mechanical genesis of the segmentation of the vertebrate skeleton was due to transverse strains, the segmentation of the bodies of worms and arthropods, as well as of vertebrates, has been discussed by recent workers (Rider, Cope, Meyer, Tornier, Hirsch, and others). Here should be mentioned the work done in general physiology, or morphogenesis, by Verworn, Davenport, and others. Also the discoveries of Pasteur, and the application by Metschnikoff and of Kowalevsky of phagocytosis to the destruction and renewal of tissues during metamorphosis, bear closely on evolutional problems.

(7) A new field of research founded by Semper, Vilmorin, and Plateau, and carried on by De Varigny, is that of experimental evolution, involving the effects of artificial changes of the medium, including temperature, food, variation in the volume of water and of air, absence of exercise, movement, &c. Also should be added horticultural experiments which have been practised for many years, as well as the results of acclimatisation.

Here should be mentioned the experiments bearing on the mechanics of development (Entwickelungsmechanik der organismen), or experimental embryology, of Oscar Hertwig, Roux, Driesch, Morgan and others, and the curious results of animal grafting and of mutilations of the embryos, obtained by Born and others, as well as the regeneration of parts. The remarkable facts of adaptation to new and unfavourable conditions of certain embryos are as yet unexplained, and have led to considerable discussion and research.

(8) The *à priori* speculations of Darwin, Galton, Spencer, Jaeger, Nusbaum, Weismann and others, based on the results of the labours of morphologists and cytologists, have laid the foundation for a theory of the physical basis of heredity, and for the supposition that the chromatin in the nucleus of reproductive cells is the bearer of heredity. The theory has already led to prolonged discussions, and opened up new lines of work in cytology and embryology.

(9) The subject of instinct, discussed from an evolutional point of view, both by morphologists and psychologists, particularly by Lloyd Morgan, has come to the front, while mental evolution has been discussed by Romanes and others.

With all these theories before us, these currents and counter-currents in evolutional thought bearing us rapidly along, at times perhaps carrying us somewhat out of our depth, the conclusion of the whole matter is that in the present state of zoology it will be wise to suspend our judgment on many theoretical matters, to wait for more light, and to confine our attention meanwhile to the observation and registration of facts, to careful experiments, and to repeated tests of mere theoretical assumptions.

Meanwhile we may congratulate ourselves that we have been born and permitted to labour in this nineteenth century, the century which in zoological science has given us the best years of Lamarck's life, a Cuvier, a Darwin, a Von Baer, an Owen, an Agassiz, a Haeckel, a Spencer, and a Huxley—the founders of modern zoology—who have sketched out the grander features of our science so completely, that it will, perhaps, be the work of many coming years to fill in the details.

Prof. Packard discussed in detail the geological causes of variation and of the extinction and renewal of species, but space cannot, unfortunately, be found to reproduce this portion of his address.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Prof. W. M. Davis, who now holds the chair of Physical Geography in Harvard University, has been elected Sturgis Hooper professor of geology in the same university.

Under the will of the late Mr. Vincent Stuckey Lean, the Trustees of the British Museum receive 50,000*l.*, to be devoted to the improvement and extension of the library and reading-room of the Museum.

The Technical Education Board of the London County Council has awarded one of its commercial scholarships to Mr. W. M. Poole, of Magdalen College, Oxford, who is an assistant-master of the Merchant Taylors' School. The scholarship is of the value of 150*l.*, and will enable Mr. Poole to proceed to some of the commercial colleges in foreign countries and study their method of commercial teaching.

The agricultural experiments carried out by Prof. William Somerville in the counties of Cumberland, Durham, and Northumberland, and the Durham College of Science, Newcastle-upon-Tyne, should prove of distinct benefit to agriculture in the North of England. The work is done in connection with the County Councils of the counties mentioned, and it forms a most valuable branch of technical education. The seventh annual report just issued contains accounts of numerous field experiments, the results of which are of scientific as well as practical value. Satisfactory evidence of interest in this phase of technical education is shown by the fact that a great demand has arisen in the county of Durham for lectures explanatory of the experimental results. Investigation has thus been the means of quickening an interest in the science of agriculture.

At the ninth meeting of University Extension and other students to be held in Oxford from July 29 to August 23, a number of lectures will be given to illustrate, as far as possible, the more remarkable contributions to science during the period 1837 to 1871. Prof. Francis Gotch, F.R.S., will deal with the physiology of sensation; Prof. E. B. Poulton, F.R.S., will deal with the modes in which the colours, markings, and attitudes of animals are of value for the struggle of life; Prof. W. J. Sollas, F.R.S., will lecture on the geology of Oxford; Prof. H. A. Miers, F.R.S., will lecture on the growth of a crystal; Mr. G. C. Bourne and Mr. A. W. Brown will deal with the growth of the living organism; Dr. Arthur Ransome, F.R.S., will lecture on hygiene; Mr. G. J. Burch on wireless telegraphy; Mr. H. N. Dickson on the influence of climate; and Dr. Reginald Farrar on anthropology. There will also be classes in geology (with field excursions conducted by Prof. Sollas), and in biology.

The London County Council has delegated to its Technical Education Board such new powers and duties as it has acquired by receiving recognition under Clause vii. of the Directory of the Department of Science and Art (see p. 498). The Board is communicating with the various schools and institutions which are in receipt of grants both from the Board and from the Department, with a view to making the necessary arrangements for carrying out the provisions of Clause vii. The new Board recently appointed consists of twenty representatives from the London County Council, three from the London School Board, two representing the City Parochial Charities Foundation, three appointed by the City and Guilds of London Institute, three from the London Trades Council, and one each from the Incorporated Association of Headmasters and the National Union of Teachers. There are in addition two co-opted members. The Board have decided to introduce some important changes into the regulations for intermediate county scholarships, and the alterations will take effect in the examination to be held in June, 1900.

SCIENTIFIC SERIALS.

American Journal of Science, March.—Studies in the Cyperaceæ, by T. Holm. This article deals with the genus *Lipocarpha*, formerly regarded as a species of Hypælyptum.—The constitution of the ammonium-magnesium phosphate of analysis, by F. A. Gooch and Martha Austin. The presence of ammonium chloride or other ammonium salt is necessary in the precipitation of manganese as the ammonium-manganese phosphate by microcosmic salt, in order that the precipitate may have the ideal constitution NH_4MnPO_4. Further research shows that the chemical constitution of the precipitate rather than mechanical contamination and varying solubility may be responsible for observed variations in the weight of the residue derived by the ignition of the similar salt of magnesium NH_4MgPO_4, precipitated by an excess of a soluble phosphate from the solution of a magnesium salt.—The crystal symmetry of the minerals of the mica group, by T. L. Walker. The examination of crystals not only by the goniometer, but also by the etching progress, and as regards their optical, electric, thermal and cohesive properties, has had the effect of a widespread degradation of crystals from systems of higher to systems of lower degree of symmetry. This tendency is especially shown by minerals of the mica group. Biotite, phlogopite, rubellan and lepidolite are not monoclinic but triclinic, while muscovite is either monoclinic, or, if it be triclinic, it is so very finely polysynthetically twinned that we cannot find a triclinic individual large enough to respond to the optical or etching method.—Imperfectly known and new Actinians, by A. E. Verrill. The specimens described include a new genus *Phelliopsis*, having a general appearance and habit resembling *Phellia*, and two new species, *Anthopleura japonica* and *Bunodactis manni*.—Some American fossil Cycads: Part i., the male flower of Cycadeoidea, by G. R. Wieland. The living Cycads constitute one of the most ornate and characteristic orders of plants, and occupying, as they do, a position on the border-land between the higher Cryptogams and the lower Phanerogams, their ancestral relationship is of considerable interest. The author has examined a collection of rare fossils from the Rocky Mountains, now in the museum of Yale University. The results strengthen the belief that the relation between Ferns and Cycads must have been a very close one.—Footprints of Jurassic Dinosaurs, by O. C. Marsh. One of the most interesting geological discoveries during the past season in the Black Hills region was a locality of footprints made by Dinosaurian reptiles in deposits of Jurassic age. These footprints are the first found in American Jurassic strata. They are all tridactyle, of large size, and were evidently made by some of the great Dinosaurs known to have lived during Jurassic time.—A new Kansas meteorite, by H. L. Ward. This meteorite was found in Ness County, and weighs 417 grms. It no longer has the usual black crust.

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 2.—"On Hydrogen Peroxide as the active Agent in producing Pictures on a Photographic Plate in the Dark." By Dr. W. J. Russell, V.P.R.S.

In previous papers the author has been shown that certain bodies are able, in the dark, to act on a photographic plate and produce a picture. The present communication shows that in all the cases which have been examined, and probably in all others of a similar kind, the action which occurs is due directly or indirectly to the presence of hydrogen peroxide.

March 9.—"A Preliminary Note upon certain Organisms isolated from Cancer, and their Pathogenic Effects upon Animals." By H. G. Plimmer, Pathologist, and Lecturer on Pathology and Bacteriology, St. Mary's Hospital, London. Communicated by Prof. J. Rose Bradford, F.R.S.

During the past six years I have been studying the cell-inclusions found in cancer, and for this work I have had to examine 1278 cancers taken from various organs and parts. Out of this large number of cases there have been a few—nine in all—in which the cell-inclusions have been extremely numerous; so that at the growing edge, and even far into the tumour, scarcely a cell could be found without an inclusion, sometimes with as many as thirty-six, even, of these inclusions in one cell; and these bodies have been similar to those which Metschnikoff, Ruffer, and others, as well as myself, have regarded and described as parasites, standing in causal relationship to the disease.

It will be seen that I mean by "cell-inclusions" those bodies found in cancer cells which are not recognisable as any known degeneration, and which do not form any part of the cell.

I have succeeded in isolating from the last of these cases, an organism, which is pathogenic, in a peculiar manner, to certain animals, and whose virulence I have been able to keep unimpaired for some months.

Previous Work on the Experimental Production of Tumours in Animals.

The only work, I think, that needs mention here is that of Sanfelice, in Cagliari, and of Roncali, in Rome. Sanfelice has produced tumours in animals with organisms which he isolated from infusions of various fruits; and they both have isolated organisms from cancers. But Sanfelice's organism appears to have been very difficult to isolate in a virulent form from human cancer, and to keep virulent; so that in his last paper,[1] he treats only of the organisms derived from fruit infusions, and of their effects upon animals. Most of their statements are doubted by the German pathologists, including such a good observer as Baumgarten. But I do not find any reason to doubt any of Sanfelice's statements; and I think that he deserves the greatest credit for removing the study of the ætiology of cancer from the histological to the experimental region of work.

On the Method of Isolation adopted.

The cancer, from which the organisms described were isolated, and with which my experiments have been made, was taken from the breast of a woman aged thirty-five years; it had a history of only two months' duration, and it was growing rapidly at the time of the operation. Immediately after removal, I examined a fresh scraping, and, finding such an extraordinary number of the bodies I have mentioned in the cells, I cut thin slices from the growth, which I placed with a little of the juice scraped from the cut surface in a flask containing the following liquid, which was of course carefully sterilised. This medium consisted of an infusion made from cancer, just as the ordinary beef infusion is made, to which was added, after careful neutralisation, 2 per cent. of glucose and 1 per cent. of tartaric acid. Upon this medium scarcely any bacteria, however hardy, will grow; so that contaminations are not common.

Then, remembering that in the body these organisms were under anaërobic conditions, I exhausted the air from my flasks, and passed hydrogen into them, finally sealing them up. This I have found is of great importance as regards the maintenance of the virulence; and I find that my cultures are as active now as they were four months ago. By these means, I got, after from three to five days, a pure culture of the organism described, which has been kept growing in this, and various other media, ever since.

Morphology and Relation to Media.

The organism is apparently a saccharomyces; but, according to some authorities (such as De Bary, Cuboni, and Duclaux), the saccharomycetes are nothing but the developmental stages of fungi which really belong to either the Phyco-, Asco-, or Basidio-mycetes. Moreover, they state that in some species of mycelium-forming fungi, single parts, especially conidia, can grow in the saccharomyces form on certain nutrient media; so I will not attempt to locate this organism at present. Sanfelice and Roncali, however, definitely state that the organisms they have isolated are Blastomycetes.

When grown in the medium described, these organisms produce a cloudiness which becomes visible in about forty-eight hours, and increases till about the sixth day, when the growth sinks to the bottom, the medium then becoming clear; no scum or pellicle is formed.

When grown on this medium solidified with agar, the organisms form small round colonies which remain separate; after some weeks the colour, which was originally white, becomes yellow; the colonies do not attain a large size at any time.

Gelatin is not liquefied, but the growth on this medium is never luxuriant. On potato a thick white layer is formed, which in about two weeks will cover the entire surface, changing then to a yellowish brown colour.

They will grow aërobically, but not well, at any rate at first; and they lose their virulence in a short time, when grown in this way.

Microscopically they are round bodies, frequently growing in clumps, with a central portion which stains deeply, and, in most cases, with a thin, strongly refractile capsule, which sometimes shows a double contour; but young forms can be seen which are without a capsule. The size varies from 0·004 mm. to 0·04 mm.

Their reproduction appears to be by budding; but I have fancied that I have also seen, in a few instances, endogenous budding.

These bodies correspond morphologically with those found in the original tumour, and also with those described by Ruffer and myself, and by some others of those who have worked at the microscopical appearances of cancer.

Experimental Results.

These can be summarised under the four following divisions. Up to the present, I have not been able to make any such experiments upon animals as would allow of the easy bringing of the organisms into contact with a likely epithelial surface, with the exception of the cornea; but, through the kindness of Dr. Bradford, I have been enabled now, at the Brown Institution, to inoculate a bitch in the mammæ, but the time is as yet too short to enable me to make any statement as to the result.

The cultures used in the experiments were made in the medium previously described.

(1) Negative results. Rabbits inoculated intravenously and intraperitoneally; and rabbits and guinea-pigs inoculated subcutaneously. The animals were killed in from fifteen days to fourteen weeks. I have left none longer than this.

(2) Those animals in which death was produced without any obvious lesion; but from the organs of which pure cultures of the organism were made. These consisted of rabbits which were trephined, the organisms being then placed under the dura mater. The organisms were present in the brain, cord, and viscera.

(3) Corneal inoculation, in rabbits, in which true neoplasms were produced. There was considerable proliferation of the corneal epithelium, which had forced its way in all directions from the point of inoculation, deep down into, and between, the fibrous layers of the corneal tissue. The organisms were found in the epithelial cells.

(4) Positive results: the animal dying with the production of new growths. These results are found in guinea-pigs inoculated intraperitoneally. Death ensues in from thirteen to twenty days: and the liver, lungs, and peritoneum are found studded with new growths of a white colour, which are of an endothelial nature. Pure cultures could be made from the growths.

The important point of this work is: the experimental production of malignant tumours in animals by an organism isolated from a malignant tumour in man. That these experimental tumours are, so far with one exception, of endothelial origin is due to the fact that until I was enabled to inoculate a dog, I found it very difficult to get the organism in contact with likely epithelium; all the above methods of inoculation, save one, could only bring them into contact with endothelial surfaces. The corneal experiment is the only one in which an epithelial surface was tried; and in this case the great proliferation of the epithelium, the appearances of the organisms in the cells, and the irritation produced, are very striking.

[1] "Zeitschrift für Hygiene," 1899.

The deductions which I think may fairly be made from these observations and experiments are as follows:

(1) That there are certain cancers, which occur very rarely, in which there are in enormous numbers, intracellular bodies of the kind described by Ruffer, myself, and others, as parasitic Protozoa. (From the rarity of these cases and their comparatively acute course, one is tempted to think that they are not due to the same cause as ordinary cancers; but there is really no more difference between them and ordinary cancers than between acute and chronic tubercle.)

(2) That these intracellular bodies can be isolated and cultivated outside the body.

(3) That these cultures, when introduced into certain animals, can cause death, with the production of tumours; so far, with the exception of the corneal growths, of endothelial origin; and that pure cultures can be made from these growths, which, when inoculated into suitable animals, will produce similar tumours.

Linnean Society, March 16.—Dr. A. Günther, F.R.S., President, in the chair.—Dr. John Lowe communicated some observations on the fertilisation of *Araujia albens*, G. Don, a Brazilian climber, which in the south of England grows in the open air. Last summer it was blooming freely in Lord Ilchester's garden at Abbotsbury, where the flowers were visited by numbers of butterflies, diurnal moths, humble-bees, wasps, and large flies, many of which were captured and imprisoned for a time in the pinching-bodies (*Klemm-körper* of Muller). All these insects, with the exception of some humble-bees, in their visits to the nectar left their proboscis behind, and sometimes a leg, being not strong enough to detach the pinching-body. Dr. Lowe described the structure of the pinching-bodies, which are flat horny plates situated, above the nectar-cups, at each angle of a five-sided hollow cone in the centre of the flower, in which is placed the stigma. There is only a small opening at the apex and a narrow slit at the base of each facet of the cone. To the upper point of the pinching-body the pollinia are attached. When an insect has its proboscis caught in the slit, which narrows always to its point, it can only escape by tearing away the body with its pollen-masses or by leaving its proboscis in the slit. In the former case it carries the pollinia to the next flower it visits, and thus effects cross-fertilisation by leaving the pollen-mass between the anther-wings, whence it rapidly passes into the cone. He had received a number of flowers of *Araujia* from Mr. Benbow, the gardener at Abbotsbury, in some of which he found the proboscis of a butterfly or moth in each of the five angles of the cone, showing the great destruction of insect-life caused by the plant. Mr. N. E. Brown, who has made a special study of the Asclepiadaceæ, gave an interesting account of the manner in which the pollinia reach the stigma; and some further remarks were made by Mr. A. W. Bennett.—Mr. P. Chalmers Mitchell read a paper on so-called "quintocubitalism" in the wing of birds. He showed that the terms "aquintocubital" and "quintocubital," applied to birds because of certain conditions in the wings, were misleading, and proposed the new terms "diastataxy" and "eutaxy." From general considerations based on the anatomy and osteology of *Columbae*, he concluded that the eutaxic forms were clearly more highly specialised forms, and that they had been derived from diastataxic forms. Comparative anatomy making it exceedingly probable that "diastataxy" is the primitive condition among birds, Mr. Mitchell proceeded to show that the primitive existence of a gap was not difficult to explain.—Mr. W. P. Pycraft read a paper entitled "Some facts concerning the so-called 'aquintocubitalism' in the bird's wing." He showed, by means of a series of lantern slides, that "aquintocubitalism" was due to a shifting, backwards and outwards, of the secondary remiges 1–4 and of the horizontal rows of coverts 1–5. The terms—suggested by Prof. E. Ray Lankester—"stichoptilous" and "apoptilous" were proposed as substitutes for the older and less convenient terms quinto- and aquinto-cubitalism. All wings, it was shown, are, in the embryo, stichoptilic, and later may become apoptilic. Hence the author felt inclined to regard the former as the more primitive arrangement. Prof. E. Ray Lankester, F.R.S., in some remarks upon the two preceding papers, gave reasons for preferring the terms "stichoptilous" and "apoptilous" in substitution for those which had been adopted by the authors. Both authors were agreed on the main issue, at which they had arrived independently, one through the study of development, the other through that of adult anatomy.

Geological Society, May 18.—W. Whitaker, F.R.S., President, in the chair.—Relations of the chalk and drift in Möen and Rügen, by Prof. T. G. Bonney, F.R.S., and the Rev. Edwin Hill. These two islands are separated in a north-westerly to south-easterly direction by about thirty-five miles of sea. They both exhibit at many spots the chalk and drift, in relations which are peculiar and abnormal. Some geologists maintain that the glacial beds have been included in the chalk by a series of acute folds; others that they have been dropped down by a series of faults; others, again, explain the relationship as the result of ice-action. Simple faulting appears to be insufficient, while it is a circumstance not easily explained by earth-movement or ice-action that the axes of the folds in the chalk strike roughly east-north-east to west-south-west in Möen, and north and south in Rügen. The authors then describe a series of sections in Möen, which lead them to the following conclusions: (*a*) The chalk dominates greatly over the clay, the latter being often merely a local phenomenon. (*b*) The chalk is stained brown, and the clay streaked with chalk for a few inches from the junction. (*c*) The clay is often a mere facing to the chalk, or occupies semi-cylindrical or wedge-shaped cavities, which sometimes seem to terminate above sea-level. (*d*) The clay seems often associated with superficial ravines, which are probably never much prolonged below the sea-level. The chalk is strongly folded, but rarely, if ever, faulted, and there is no evidence to connect the intercalations of drift with faults. Numerous sections in Rügen are then described, which (though there are differences in detail) present a general resemblance to those in Möen, and, as a rule, have no resemblance to those near Cromer.—A critical junction in the County of Tyrone, by Prof. Grenville A. J. Cole. The investigations of the author have led him to the conclusion that the granite of Eastern Tyrone is identical with that of Slieve Gallion.

PARIS.

Academy of Sciences, March 27.—M. van Tieghem in the chair. Obituary notice of M. Charles Naudin, by M Ed. Bornet.—M. Gaudry announced the death of Prof. O. C. Marsh, Correspondant in the Section of Mineralogy.—The Perpetual Secretary announced the death of Prof. G. H. Wiedemann, Correspondant in the Physical Section.—Obituary notice of Prof. Wiedemann, by M. Mascart.—The deformation of surfaces of the second degree, by M. G. Darboux.—The effect produced upon the motion of inclination of a bicycle by the lateral displacements given by the rider, by M. J. Boussinesq.—Note on some properties of the radiation of uranium and radio-active substances, by M. Henri Becquerel. The intensity of the uranium radiations, as measured by their photographic action, appears to undergo no diminution with time, since some uranium compounds enclosed in a leaden box since May 1896, and hence absolutely shut off from all known sources of radiation, still have the same action upon a photographic plate as when first set up. The rays do not appear to be capable of polarisation, all attempts to repeat two early experiments giving positive results in this direction having failed. Bodies, such as glass, receiving these rays, give off a secondary radiation very similar in nature to that observed by M. Sagnac for the X-rays.—On the explosive aptitude of acetylene when mixed with inert gases, by MM. Berthelot and Vieille. Two sets of mixtures were examined, acetylene and hydrogen, and acetylene and coal gas. These were gradually compressed, and the pressure zone determined within which the propagation of the explosive wave was possible.—Preparation and properties of crystallised calcium phosphide, by M. Henri Moissan. By carefully heating an intimate mixture of carbon and calcium phosphate in the electric furnace, it is possible to obtain a crystallised calcium phosphide containing only traces of calcium carbide and unreduced phosphate. The phosphide obtained in this way forms reddish-brown crystals, which fuse only at a very high temperature. Chlorine is without action in the cold, but a violent reaction sets in at 100° C. Analyses show that the composition of the phosphide is Ca_3P_2.—On the properties and applications of aluminium, by M. A. Ditte. Copper-aluminium alloys containing from three to six per cent. of copper are more readily attacked by aqueous solutions than aluminium itself; the copper remaining untouched forms innumerable couples tending to accelerate the solution of the more easily oxidisable metal.—Observations of Swift's comet (1899 *a*), made with the

large equatorial of the Observatory of Bordeaux, by MM. G. Rayet and F. Courty.—Observations of the sun, made at the Observatory of Lyons, during the last quarter of 1898, by M. J. Guillaume. The results are formulated in three tables giving the number and area of sun-spots, their distribution in latitude, and the distribution of the faculæ in latitude.—On functions defined by a Taylor's series, by M. L. Leau.—On some arithmetical properties of analytical functions, by M. Paul Staeckel.—On the existence of fundamental functions, by M. W. Stekloff.—On functions of several variables, by M. H. Lebesgue. On the magnetic elements in Roumania on January 1, 1895.—A question of priority concerning the equation $k - i/(k + 2)d =$ constant, between the dielectric constant and the density, by M. D. Negreano. This relation was given theoretically by H. A. Lorentz in 1880, and proved experimentally by the author in 1887 to be true for several hydrocarbons. The Mosotti-Clausius formula, $g = k - i/k + 2$, where g is the distance between the molecules, is not identical with the above, as the density does not appear.—On the Wehnelt commutator, by M. H. Pellat.—On a new apparatus designed to show the space relation of radiographs, and to search for foreign bodies, by M. A. Londe.—Transformation of the Galilean telescope into a range-finding instrument, by M. G. Humbert.—On the mixture of gases and the compressibility of gaseous mixtures, by MM. Daniel Berthelot and Paul Sacerdote. Experiments were carried out on mixtures of carbon dioxide and sulphur dioxide, air, and a mixture of hydrogen and oxygen.—On the decomposition of carbonic oxide in presence of metallic oxides, by M. O. Boudouard. The oxides of iron, nickel and cobalt were studied, at a temperature of 650°, the softening point of the glass tubes used, and the composition of the gaseous mixture determined as a function of time of contact with the oxide.—On the decomposition of carbon dioxide in presence of carbon, by M. O. Boudouard. A similar set to experiments to those described in the preceding paper, but with charcoal taking the place of the metallic oxides.—On the dissociation of mercuric oxide, by M. H. Pélabon.—Action of the bis-diazoic chlorides of benzidine, of ortho-toluidine, and of dianisidine upon the malonates of ethyl and methyl, by M. G. Favrel.—Detection of mercury in the produce of vines treated with mercurial broths, by MM. Leo Vignon and J. Perraud. The amounts of mercury found are so small that, in the author's opinion, the utilisation of mercuric chloride for the treatment of diseases of the vine is subject to no serious objections from the hygienic point of view; but the action on the plant itself is so serious, that for this reason alone corrosive sublimate should not be used in combating diseases of the vine.—Remarks by M. Berthelot on the preceding paper.—Toxic albumen extracted from the flesh of the eel, by M. Elophe Bénech.—Morbid predispositions of the puerperal period, by M. A. Charrin.—Action of the pancreas upon the diphtheric toxin, by MM. Charrin and Levaditi. The pancreas exerts an attenuating action upon bacterial toxins. Death from continuous electrical currents, by MM. J. L. Prevost and F. Battelli.—Researches on the sensitive nerve terminations in voluntary striated muscle, by M. D. Polonmordwinoff.—*Botrytis cinerea* and the disease of *la toile*, by M. Beauverie.—On a tachylite from the bottom of the N. Atlantic, by M. P. Termier.—On the captive balloon ascents of March 24, by M. Léon Teisserenc de Bort.

DIARY OF SOCIETIES.

THURSDAY, April 6

Linnean Society, at 8.—On *Carex Wahlenbergiana*: C. B. Clarke, F.R.S.—On the Discovery and Development of Rhabdites in Cephalodiscus: F. J. Cole.

FRIDAY, April 7.

Geologists' Association, at 8.—The Geology of Brittany, with Special Reference to the Whitsuntide Excursion: Dr. Charles Barrois.

SATURDAY, April 8.

Geologists' Association. Cycling Excursion—Winchfield to Wokingham. Director: H. W. Monckton.

MONDAY, April 10.

Society of Chemical Industry, at 8.—The Industrial Technical Treatment of Sherry and of British Colonial Wines: Dr. J. T. W. Thudichum.

Victoria Institute, at 4.30.—Babylonian Deities: Theo. G. Pinches.

TUESDAY, April 11.

Royal Institution, at 3.—Zebras and Zebra Hybrids: Prof. J. Cossar Ewart, F.R.S.

Institution of Civil Engineers, at 8.—Paper to be further discussed: Alloys of Iron and Nickel: Robert Abbott Hadfield. And, time permitting: Buenos Aires Harbour Works: James Murray Dobson.

Mineralogical Society, at 8.—On a Mass of Meteoric Iron lately found in Patagonia: L. Fletcher, F.R.S.—On Langbeinite from the Mayo Salt Mines, in the Punjab: F. R. Mallet.—On the Use and Advantages of a Three-Circle Goniometer: G. F. Herbert Smith.

Royal Photographic Society, at 8.—The Correct Exposures to be given to Photographs of the Corona: E. W. Maunder.

WEDNESDAY, April 12.

Society of Arts, at 8.—Telephones: John Gavey.

Geological Society, at 8.—(1) Fossils in the University Museum, Oxford. I. Silurian Echinoidea and Ophiuroidea; (2) On the Occurrence of Sponge-Spicules in the Carboniferous Limestone of Derbyshire: Prof. W. J. Sollas, F.R.S.—On Spinel and Forsterite from the Glenelg Limestone: C. T. Clough and Dr. Wm. Pollard.

THURSDAY, April 13.

Royal Institution, at 3.—The Atmosphere: Prof. J. Dewar, F.R.S.

Mathematical Society, at 8.—Note on the Characteristic Invariants of an Asymmetric Optical System: T. J. Bromwich.—Concerning the Four Known Simple Linear Groups of Order 25920, with an Introduction to the Hyper-Abelian Linear Groups: Dr. L. E. Dickson.—On the Direct Determination of Stress in an Elastic Solid, and on the Stress in a Rotating Lamina: J. H. Michell.—The Theorem of Residuation, Noether's Theorem, and the Riemann-Roch Theorem: Dr. F. S. Macaulay.

Institution of Electrical Engineers, at 8.

FRIDAY, April 14.

Royal Institution, at 9.—Earth Currents and Electric Traction: Prof A. W. Rücker, Sec. R.S.

Royal Astronomical Society, at 8.

Malacological Society, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—On Birds and Stipules: Sir John Lubbock (Paul).—National Association for the Promotion of Technical and Secondary Education, 11th Annual Report (London).—Massachusetts Institute of Technology, Boston, Annual Catalogue, 1898–99 (Boston).—Text-Book of the Embryology of Invertebrates: Drs. Korschelt and Heider, Vol. 2, translated by M. Bernard (Sonnenschein).—Report of Observations of Injurious Insects, &c., during the Year 1898: E. A. Ormerod (Simpkin).

Pamphlets.—The Future of the Metric and Imperial Systems of Weights, &c.: J. Manning (Sonnenschein).—Une Excursion Electrotechnique en Suisse (Paris, Gauthier-Villars).

Serials.—Contemporary Review, April (Isbister).—National Review, April (Arnold).—National Geographic Magazine, March (Washington).—Lehrbuch der Allgemeinen Chemie: Dr. W. Ostwald, ii. Band, 2 Teil, 4 Liefg. (Leipzig).—Fortnightly Review, April (Chapman).—Reliquary and Illustrated Archæologist. April (Bemrose).—Journal of Botany, April (West).—Proceedings of the Royal Society of Victoria, Vol. xi., new series, Part 2 (Melbourne).—Journal of the Royal Agricultural Society of England, Vol. x. Part 1 (Murray).—Observatory, April (Taylor).—Notes from the Leyden Museum, October, 1898 (Leiden).—Minnesota Botanical Studies, Part 2 (Minneapolis).—Chambers's Biographical Dictionary, Part 1 (Chambers).—Ditto, English Dictionary, Part 1 (Chambers).—Natural Science, April (Pentland).

CONTENTS.

THURSDAY, APRIL 13, 1899.

EARLY ASTRONOMY.

Researches into the Origin of the Primitive Constellations of the Greeks, Phoenicians and Babylonians. By Robert Brown, jun. Vol. i. Pp. xvi + 361. (London: Williams and Norgate, 1899.)

THE early history of the science of astronomy is a very fascinating, but also a very difficult, subject for study, inasmuch as it is almost impossible to say with certainty at what point astrology ends and astronomy begins. That accurate observations of the stars were made by the Egyptians at a very remote period of their history, has been conclusively proved by Sir Norman Lockyer, from a study of the orientation of the principal Egyptian temples; but in its dawn astronomy was of an essentially religious and magical character. The desire to obtain a knowledge of the future from the aspect of the heavens, was doubtless one of the principal motives which actuated the Egyptians, the Chinese, and, in particular, the Babylonians in their earlier observations of the stars; and it was only after many centuries that the practice of astrology gave place to more scientific aims and methods. That the Babylonians took astronomical observations from an early period is attested by general tradition, which in some cases, however, exhibits curious exaggeration. Pliny, for instance, refers to certain calculations in accordance with one of which the Babylonians possessed recorded observations extending over a period of 490,000 years, while according to another their calculations reached back to some 720,000 years. Yet, in spite of such absurdities, there was doubtless a substratum of truth in the tradition, and it is probable that the Babylonians, like the ancient Egyptians, from a very remote period were watching the stars and laying the foundations of astronomy. During the Assyrian empire we know that important astronomical schools existed at Ashur, Nineveh and Arbela in the eighth and seventh centuries B.C., and a number of reports made by the royal astrologers have come down to us. From these reports, and from the lists of stars, observations and calendars of the same period that we possess, we may conclude that at this time the science was still in its astrological stage of development.

Some eighteen years ago excavations were undertaken at Abu-Habbah, the site of the Babylonian city of Sippar, and they resulted in the discovery of numerous fragments of astronomical tablets belonging to the Seleucid and Arsacid eras. They are written in the late Babylonian cursive form of writing, and were found to be very difficult to decipher; but, after several years of patient study, Dr. Strassmaier and the late astronomer Dr. Epping, working in collaboration, succeeded in accurately determining the contents of many of them. From them we gather that the later Babylonians, although they made their calculations solely by the cumbrous processes of addition and subtraction, did study astronomy on a purely scientific basis. It is true they had no correct conception of the solar system, but they had at least arrived at the conclusion that the motions of the heavenly bodies were governed by laws and were amenable to calculation; in fact, the tablets prove that they calculated the time of the new moon's appearance, and the periodical occurrence of lunar and solar eclipses, that they noted the courses of the planets, and included in their observations a number of the principal constellations and fixed stars. In consequence of these discoveries it is now a generally accepted opinion that the Greeks obtained from the Babylonians of this period the greater part of their knowledge of astronomy.

According to its title-page, Mr. Robert Brown's book is concerned with the "Primitive Constellations of the Greeks, Phœnicians and Babylonians," whatever that may mean. We have read Mr. Brown's book through, and, so far as we understand his position, we gather that he has two principal convictions with regard to the history of early astronomy. One is that the Greeks had a very full and accurate knowledge of the constellations from the earliest period of their history; the other is that they gained their knowledge at this early period from the Babylonians, through intercourse with the "Hittites" and the Phœnicians. In accordance with his first supposition, Mr. Brown attempts to trace the constellations mentioned by late Greek writers on astronomy to corresponding Akkadian, Babylonian or Assyrian stars and deities; in accordance with his second supposition, he asserts that the Greeks of the Homeric and pre-Homeric ages were quite familiar with the names of the constellations known to their later descendants. Mr. Brown's methods of proof, if we may so term them, differ for these two theories; for the first they are philological, for the second archæological. Mr. Brown devotes the earlier part of his book to developing his first theory, but for the sake of convenience we will reverse his order.

To prove that the early Greeks were familiar with the later Greek names for the constellations Mr. Brown depends on certain passages in Homer, the figures on Greek coins, and representations in early Greek art. Mr. Brown's method is simple enough; he approaches his subject with his theory ready made, and looks round for evidence to support it. For instance, the Homeric poems "speak of serpents, horses, charioteers, archers, wreaths, lyres, birds, rams, goats, virgins, doves, fishes, streams, altars, and tripods" (p. 248). Mr. Brown admits that in mentioning an eagle or a hare, Homer may have no further meaning than to refer to them as living creatures; but he proceeds to note as "a singular fact" that "the poems contain references to almost every figure which formed one of the primitive constellations." Mr. Brown makes the same sort of remarks about the figures of animals, &c., on early Greek coins, which he would like to regard as symbols for constellations, or, at any rate, as "constellational subjects." With regard to such designs upon coins, which have given rise to a good deal of discussion, Prof. Ridgeway in his work upon the origin of currency has developed the very ingenious theory that they represented objects of barter, which in course of time were displaced by the more convenient metallic currency. It is possible that Prof. Ridgeway has carried his theory too far in certain

directions, but he is at any rate a scholar who works on a scientific method, and the mass of evidence he has accumulated must be either accepted or refuted by any subsequent writer on the subject. Mr. Brown, however, is not concerned with such a prosaic pursuit as the weighing of evidence. To his eyes all beasts and birds on coins assume a stellar aspect, and are at once classified in his book as "constellational"; in fact he believes he has discovered that constellation-figures "simply swarm" in coin-types (p. 239). Similarly he has no difficulty in finding "constellational subjects" in Schliemann's finds at Tiryns and Hissarlik, in the "Hittite" hieroglyphs, and in Mr. Evans's Cretan pictographs. Such wholesale assertions are not evidence, and all that is needed to refute them is a little common sense.

Mr. Brown's method of work with regard to his other conviction, which is developed in the earlier part of his volume, is equally simple, though it might not seem to be so from the learned appearance of his pages. He takes Ptolemy's catalogue of stars from the Almagest, and for each constellation proceeds to find some star or deity known to the Akkadians, Babylonians or Phœnicians, to which he may equate it. In the present state of knowledge on this subject, such comparisons, if undertaken by a competent scholar, would necessarily be made in a very tentative manner, and only after a thorough acquaintance at first hand with the literatures and inscriptions of the nations concerned. Mr. Brown has no misgivings, and finds his equations with the greatest ease; in the process, however, he proves that his knowledge of the languages he quotes is not obtained at first hand, and that he has not sufficiently qualified himself for his task. He is careful to state that in the spelling of names he adopts "the original forms, because they are the most correct"; he follows this plan, he tells us, even at the risk of being accused of pedantry, for he does not hold with those "who think that Time can consecrate error and canonise ignorance." Thus he writes "Babylôn" and "Euphratês," and refers to Darius as "Dârayavaush." Mr. Brown, however, was not well advised to adopt so high a standard, for in seeking to attain it he has fallen into a good many errors of his own making. For instance, he incorrectly writes "Tukulti-pal-esar" (p. 47) for Tukulti-pal-Eshara when Tiglath-pileser would have done equally well; and in referring to Borsippa as "Barsipki" (p. 327) he has transliterated the determinative particle *ki* as though it were a syllable of the name. His references to Hebrew, Phœnician and Assyrian words, moreover, show that he is not acquainted with these languages, for he unwittingly makes use of quite different systems of transliteration. When citing the Hebrew for "serpent" as "nâkhâsch" (pp. 29, 119, &c.), and when referring to the Phœnician deity "Eschmûn" (p. 168), he is evidently drawing on some German work; while elsewhere he renders the Hebrew and Phœnician sound *sh* in the ordinary English method; similarly the Assyrian for "heaven" is not *same* (p. 57), nor *samê* (p. 269), nor *sami* (p. 287), but *shamê*. Mr. Brown gets into a good many difficulties with his sibilants in quoting Assyrian words; he states in his preface that instead of using diacritical marks he employs *kh*, *ts* and *sh*, yet he cites the Assyrian for "king" as *sarri* (pp. 34, 62, &c.) instead of *sharru*; he translates the relative pronoun as *sa* instead of *sha* (*passim*), he writes *saplitu* for *shaplitu* (p. 116), *risi* for *rêshi* (p. 81), *satti* for *shatti* (p. 267), *Gilgames* for *Gilgamesh* (p. 46), *Samas* for *Shamash* (*passim*), &c. Now Prof. Sayce, in his popular works on Assyrian, purposely makes no distinction between his sibilants—a very reprehensible practice according to Mr. Brown's preface, and we venture to offer Mr. Brown our sincere sympathy for having himself, through ignorance of this fact, helped to "consecrate and canonise" so many errors.

Mr. Brown, however, makes worse mistakes than these, for he really ought to know there is no *h* either in Assyrian or in Akkadian, and he might be expected to know the difference between a consonantal and a quiescent *hê* in Hebrew; moreover, he seems ignorant of the construct state, and appears to be unaware of the fact that you cannot have a long vowel in a closed syllable in Hebrew unless it has the tone. These would be bad blunders in a beginner, and are scarcely expected in the work of a comparative philologist; it is hardly necessary to follow Mr. Brown further in his numerous philological comparisons.

We have, perhaps, devoted more space to this book than it deserves, though we have not mentioned more than a few of the extraordinary blunders we have come across during its perusal. The manufacture of books of this nature can surely serve no useful purpose.

LIFE ON AN ATOLL.

Funafuti, or Three Months on a Coral Island; an Unscientific Account of a Scientific Expedition. By Mrs. Edgeworth David. Pp. xvi + 318. With Portraits, Map, and Illustrations. (London: John Murray, 1899.)

MRS. DAVID accompanied her husband on the second boring expedition to the atoll of Funafuti, when, under his directions, a depth of 643 feet was attained. The island is one of the Ellice group, lying about 8° south of the equator, almost due north of Fiji, and so nearly half a hemisphere away from London. Selected by the Coral Reef Boring Committee of the Royal Society as a typical atoll, the chain of islands, of which it is composed, takes an outline which roughly resembles that of a shoulder of mutton, and encloses a lagoon about eleven miles in diameter.

Funafuti itself lies on the eastern side, a long, low, narrow island, composed wholly of coral and other organisms. It possesses a king and a native pastor; a church, a school-house, and even a royal residence; the latter, however, are edifices of the humblest kind, and it does not yet boast of an hotel or a lodging-house, so Mrs. David and the Professor took up their quarters in a native hut just outside the village. This had its advantages and its drawbacks; it was well ventilated, but not always rain-proof, and the domestic life was too open to inspection; for the Funafutian is as inquisitive as a child. "Fancy living, bathing, feeding, and sleeping in a one-roomed house with unhung door-spaces; a house with mat walls that are being constantly lifted by little brown hands, to let in little brown heads, with big

innocent inquiring eyes." The children might sometimes be got rid of, but the adults were greater difficulties, and as the women were more animated than the men by the true scientific spirit of seeing for themselves, Prof. David was placed in embarrassing situations oftener even than his wife. But they both accommodated themselves to circumstance with unfailing good humour, and so were evidently general favourites.

Mrs. David calls her book "an unscientific account of a scientific expedition." This in a sense is true, because there is no attempt at technical language, and long words are conspicuously absent; but every page shows close observation, keen insight, and a power of vivid description, that gives the work a real scientific value. We can almost see Funafuti, and in this are helped by sundry successful reproductions of photographs. But such a word-picture as the following suffices to bring up the scene.

> "We anchored close to the lagoon reef, about a quarter of a mile from the shore, and over the side, under the shallow water, we saw irregular-shaped masses of dun-coloured coral with myriads of brilliant fishes flashing across from hollow to hollow, inquisitive but timid. Then on the shore was a long narrow crescent of brilliant white sand, lapped by the tiny idle wavelets of the lagoon; beyond that, a line of low thick tasuna and gasu bushes, and behind a dense mass of graceful cocoa-nut palms."

In former days, the Funafutians depended wholly on the cocoa-nut palm and on fishing for subsistence, with the result that starvation times were not uncommon. Now the missionaries have taught them to cultivate bananas, bread-fruit, and taro (*Arum esculentum*), and they have pigs, goats and fowls; so that though cocoa-nut is still a staple food, the "milk" being a substitute for "afternoon tea," they are much better off. But they take life easily, and are great believers in "by-and-by." In fact Mrs. David admits that it is very hard to be energetic on an atoll near the equator, for her attempts at reading generally ended in sleep. So the natives, except when fishing or some such business calls for an exceptional exercise of energy, lead, on the whole, a very easy life. Food of a simple kind generally is fairly plentiful, their wants are few; houses, furniture, tools, utensils, even clothing, are all of the simplest. As converts to Christianity, they have abandoned the graver vices of the savage, and are accustomed to the restraints of laws, sometimes perhaps rather too grandmotherly; but yet they remain, like so many such, physically adults, but mentally and morally no more than children. Mrs. David's quick apprehension of this fact gives the book its special value. She accepted them as she found them with a sympathetic tolerance, adapting to their case the experiences learnt in her own nursery, with the result that she won their hearts and their confidence. Their language is a mixture, Samoan dominating; but some can speak our tongue, and a sort of pigeon-English is commonly understood. Mrs. David obtained copies of native songs—for a musical (?) evening is a favourite form of Funafutian recreation—and of their popular tales. The former are mostly of scriptural origin, and so have little interest; but the latter are well worth preservation as samples of Pacific Islanders' folk-lore.

Funafuti has its drawbacks as a residence. The climate leaves something to be desired; it is windy, and decidedly rainy. Flies and mosquitos abound to make life a burden, with spiders, cockroaches, and other more or less obnoxious insects, while, among creatures of larger size, land-crabs and small rats seem predominant. The natives suffer greatly from skin diseases, such as itch, ringworm, and Tonu (apparently a kind of leprosy), against which they will not take any precaution. In matters of sanitation, the native pastor is no use at all; a medical missionary, as Mrs. David says, would be, indeed, a blessing to the Funafutians. But for all their quaint, tiresome, yet lovable ways, we must refer readers to the book. Written in a bright, lively style, like a series of letters to a friend, humorous, yet kindly, full of vivid word-pictures of life and scenery, it is an unusually attractive volume. T. G. BONNEY.

NATURAL RIGHTS.

The Right to the Whole Produce of Labour. By Dr. Anton Menger, Professor of Jurisprudence in the University of Vienna. Translated by M. E. Tanner, with an Introduction and Bibliography by H. S Foxwell, M.A., Professor of Economics at University College, London. Pp. cxviii + 271. (London: Macmillan and Co., Ltd., 1899.)

PROFESSOR FOXWELL treats his part of this book as complementary to Dr. Menger's treatise, but in reality he contributes more than half of the actual printed pages. To allocate the shares briefly, Dr. Menger has analysed critically and historically the socialistic theories of natural rights; Prof. Foxwell has written the history of early English socialists, and added a complete list of their works. The main interest of the book to English readers will be this rescue from oblivion of the men to whom the whole of modern socialistic theory is originally due; they are Godwin, Hall, Thompson, Gray, Hodgskin, and Bray. Godwin's "Political Justice" (1793) analyses the right to property, regarding want as the only equitable right, thus forecasting the phrase "to each according to his needs." Hall's "Effects of Civilisation on the People in European States" (1805) contends that the chief effects are, on the one hand, a constant increase of the wealth and power of the idle rich, and, on the other, the greater poverty and subjection of the labouring poor. Thompson's "Inquiry into the Principles of the Distribution of Wealth most conducive to Human Happiness" (1824) bases his hypotheses on "the ascertained truths of political economy" of the new Ricardian school, to whose "crude generalisations" socialism owed "its fancied scientific basis," and who, "by a singular irony of fate, by this imperfect presentation of economic doctrine, did more than any intentionally socialist writer to sap the foundations of that form of society which he was trying to explain, and which he believed to be the typical and natural, if not, indeed, the ideal social state." Thompson held that "to the producer should be secured the free use of whatever his labour has produced," while the capitalist should be indemnified for the wear and tear of

his goods, and receive an income equal to that of the best workmen, but that rent and interest are only forced abstractions sanctioned by law. Here, says Dr. Menger, we find the train of thought which reappears in the writings of the well-known socialists Marx and Rodbertus. Gray, the author of "A Lecture on Human Happiness" (1825), gives an analysis of Colquhoun's table of national wealth (1814), and finds that there was produced "nearly fifty-four pounds a year for each man, woman, and child in the productive classes: of which they received about eleven pounds, being but a small trifle more than one-fifth part of the produce of their own labour!" It may be mentioned for comparison that modern statistics show that now about four-ninths of the national income is received by wage-earners. Finally he holds that the unproductive classes, as he calls them, should in his reformed community be reduced to the few necessary for superintending labour, and should devote their talents to the general good. Hodgskin, a thoroughly educated man, a friend of Francis Place, the radical, and of James Mill, was more a politician than his socialist forerunners; in his "Labour Defended" he holds that by combination the labourer may "destroy altogether the profit of the idle capitalist" in the "war of honest industry against . . . idle profligacy," and "augment the wages and rewards of industry," giving "to genius and skill their due share of the national produce." Bray, in "Labour's Wrongs and Labour's Remedy" (1839), traces social anomalies to "the institution of property as it at present exists," and works out in detail a transitional project for passing to a communistic state.

Dr. Menger proves that neither Karl Marx nor Rodbertus were original in their analysis of the cause of the "rent" "surplus value" or "unearned income," which they held must accrue to the non-workers in an individualistic *régime*, when the workers had, owing to the "iron law" of wages, received "bare subsistence," but that all their ideas came from this group of English socialists. He does not criticise the truth of their hypotheses, except by showing that the "right to the whole produce of labour" has never been recognised in any permanent legal system; but he reduces the claims of socialists to three—this "right to the produce of labour," the "right to subsistence," and the "right to labour"; he shows that these rights are not consistent with each other, examines the French attempts to give effect to one or other of these claims, showing how failure always followed, and finds that socialists have never put forward any unanimous, consistent and practical scheme for the reorganisation of society, while they have only been successful in uniting their followers on negations, or criticisms of existing ills. He is clearly not entirely out of sympathy with these criticisms, for one of his chief conclusions is that "it should be recognised as a guiding principle of legislation that all measures are to be avoided which create or increase unearned income."

The importance of the book consists to a great extent in the bibliography, which must prove invaluable to any student of the growth of socialistic ideas; though it is clear that Prof. Foxwell's industry has unearthed very many rare publications, of which copies will hardly be found except in his own celebrated library. For the ranslation we have nothing but praise. A. L. B.

OUR BOOK SHELF.

L'Audition et ses Organes. Par Dr. M. E. Gellé. Pp. 326 (Bibliotheque Scientifique Internationale.) (Paris: Félix Alcan, 1899.)

In a volume belonging to this series, one expects three primary virtues—a clear logical arrangement, a lucid method of statement, and accuracy with regard to matters of fact. The book before us attains to a fairly high standard in all these respects; it is divided into three chapters, in which the sonorous vibrations are traced in logical sequence from their origin to their final transformation into sensations of sound in the brain. A judicious use of headings in larger type is a great help to clearness; but, in a book of this kind, a little more space might with advantage have been given to the more elementary parts of the subject, especially in the physical and anatomical chapters. Misprints appear rather too frequently (*e.g.* five in 2½ lines of English quotation, p. 46), and the illustrations are often not so good as could be wished.

In the first chapter, which deals with various physical properties of sonorous vibrations, a series of phonograph tracings are given, that amongst other things show in an exceptionally clear and beautiful manner, the changes due to variations in intensity and the action of the explosive consonants on the various vowel sounds. Several of these diagrams would be improved by a fuller and more definite explanatory description. The paragraphs in this chapter on the quality of musical sounds and the formation of articulate speech strike us as especially good.

The early part of the second chapter, describing the evolution of the auditory organ within the animal series, is a weak point in the book. The subject is treated too briefly to escape ambiguity—*e.g.* from the description on pp. 140–141, no one would suppose that an external opening to the ductus endolymphaticus was a general feature among Elasmobranchs; and a little lower down the page it is far from easy, without previous knowledge, to distinguish the statements that refer to the shad from those referring to the carp. We may further mention that the auditory sac is open in the lobster, and although monotremes and many marsupials have a columelliform stapes, their ossicles cannot be said to be reduced to a columella. The remainder of the chapter—dealing with the anatomy and physiology of the human ear—is excellent. We notice that in the discussion on the external auditory meatus no mention is made of its apparent importance in the realisation of the external origin or outwardness of sounds. In the question of the mode of transmission of the sonorous vibrations through the ossicles and in the labyrinthine fluids, the author is strongly in favour of its being mainly molecular, although he allows a certain amount of movement of the ossicles *en bloc.* The pages that deal with the internal ear form certainly one of the best parts of the book.

The subject of the last chapter—the relation that exists between the brain and the auditory impulses—is one of great obscurity, and is here largely treated by the citation of cases, that bring out in various ways how entirely the perception of sound depends upon the state of the brain and nervous system. In short, this may be called a good book on a highly interesting subject.

Early Chapters in Science. By Mrs. W. Awdry. Edited by Prof. W. F. Barrett. Pp. xviii + 348. (London: John Murray, 1899.)

A volume which gives instruction in the chief biological and physical sciences in 348 pages cannot very well be satisfactory in all its parts. The aim of the present volume is to provide "a first book of knowledge of natural history, botany, physiology, physics and chemistry for young people"; and, so far as it goes, it represents a praiseworthy attempt to create and promote an interest in natural things and phenomena. The animal and vegetable kingdoms are described in two hundred pages, and

physics and chemistry in the remaining part of the book. Electricity is dealt with in sixteen pages of this part, and chemistry in twenty-eight pages. Most of the illustrations are line drawings, and will not be attractive to the young people for whom the book is intended; for few natural history objects can be well represented by outline sketches, and children often have a difficulty in understanding them.

In the preface the editor, referring to the object of the book, suggests that it should be especially useful in "the junior classes in schools." But few teachers who have had experience in giving instruction to such classes would approve of the order in which some of the subjects are dealt with. For instance, the first chapter deals with the difficult subject of classification of animals, and leaving out of account the fact that the scheme of classification described is somewhat old-fashioned, we think it pedagogically wrong to begin the study of natural history by classifying the animal kingdom. Teachers may, however, find the volume useful in providing information for lessons on natural history objects, and suggesting experiments in physics and chemistry.

Notes from a Diary in Asiatic Turkey. By Lord Warkworth, M.P. Pp. xvi + 268. (London: Edward Arnold, 1898.)

THE author of this book, now Earl Percy, travelled by several of the main routes and some unfrequented ways of Asiatic Turkey in 1897. He shows himself to be a wide-awake politician, an instructed antiquarian, and something of a sportsman; hence the narrative necessarily deals with matters from a point of view somewhat remote from the scientific. The book is charmingly got up, gracefully written, and illustrated by some choice reproductions of good photographs, one of which represents a dervish with a dagger thrust through both cheeks and apparently insensible to pain. Throughout the journey, indeed, there seems to have been very little objection on the part of the people to allow themselves and their belongings to be photographed, a result doubtless of the infiltration of Western ideas even into the remoter parts of the Turkish empire. Incidentally, one or two points of scientific interest are touched upon. The strange idea is noted that the honey of a district near Erzerum is not only poisonous when taken in large quantities, but that if the red water-melon is eaten at the same meal with some of the honey, death would result from the formation of large crystals in the stomach. A curious statement is made as to the extent of the occasional inundations of Lake Van, one of the natives declaring that the water had recently risen as much as 400 feet, a degree of flood which the author prudently views as an exaggeration. The discovery of a spring "bubbling over with a copious flow of liquid sulphur" (p. 204) would certainly be interesting, but it probably was no more than water impregnated with sulphuretted hydrogen.

As an intelligent, modest, and serious account of an interesting journey in a country still difficult of access, this book deserves very hearty commendation, and it would be gratifying to believe that all members of Parliament could make so good a use of their holidays as Lord Percy has done.

Lectures on Theoretical and Physical Chemistry. By J. H. van 't Hoff. Translated by R. A. Lehfeldt. Part I. Chemical Dynamics. Pp. 254. (London: Edward Arnold.)

TO what has already been said regarding the French edition of this excellent work (NATURE, p. 458) there is little to add. The translation is accurate, the few slips that occur being mostly referable to the original, and easy of detection. As to paper and printing the book leaves nothing to be desired, although perhaps this result has been attained at the expense of a wider popularity which the book might have enjoyed had its price been lower.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Experiment to Illustrate the Zeeman Effect.

PROF. A. GRAY has kindly called my attention to his Royal Institution lecture of April 29, 1898, in which, nearly a year ago, he pointed out the analogy between a pendulum with a gyrostat in its bob, and the molecule of a gas vibrating in a magnetic field, which I called attention to in my recent letter (p. 509). GEO. FRAS. FITZGERALD.

Trinity College, Dublin, April 5.

Formation of Egg-capsules in Gasteropoda.

THE function of the sole-gland of the foot in certain divisions of the Gasteropoda seems hitherto to have remained unknown. None of the works I have been able to consult give a definite account of the function of the organ. This sole-gland appears from the literature to exist only in the dioecious Azgygobranchia, whereas the more anterior marginal gland of the foot is found both in these and in Pulmenata and Opisthobranchia.

On the other hand, I have been unable to find any published account of the origin and formation of the horny capsules, in which the ova of most Azgygobranchia are deposited and contained during their development. Many writers seem to assume that these capsules are formed in the generative duct, which is not the case.

I have recently satisfied myself that these two gaps in our knowledge of the Mollusca are really one; in other words, that the egg-capsules are formed by the sole-gland, and that the latter is really the nidamental gland. I first discovered this in the common whelk *Buccinum undatum*, which I found in numbers in the act of spawning on the shores of Falmouth Harbour in November 1897. Pulling away the animals from the stones to which they adhered, I found incompletely formed capsules in the cavity of the sole-gland, and saw that the "spawn" was formed and deposited by the "foot." The ova are probably transferred to the cavity of the gland, before the closure and deposition of the capsule. I have recently verified the same fact in the same locality in another species, namely *Murex erinaceus*. In this case the capsule is long and narrow in shape, and I saw it in an imperfectly matured though fully formed condition, drawn out of the aperture of the sole-gland, when I detached a specimen in the act of spawning.

Lacaze Duthiers has shown that the float of *Janthina* is formed by a glandular depression of the foot corresponding to the sole-gland, and Johannes Thiele maintains that the egg-capsules of this animal, attached to the float, are produced also by a certain portion of this gland. Simroth, however, believes with Lacaze Duthiers that the "cocoons" or capsules are derived from the sexual organs. I have no doubt Thiele is right, but he does not appear to have extended his doctrine to other forms than *Janthina*.

The function of the sole-gland being thus established, the question arises whether there is not a difference in the structure or size of the gland between the male and female, since the male does not produce egg-capsules. This and other questions I must leave to be investigated in future. Not knowing when I may have leisure to make a more detailed study of the subject, I wish to make known the main fact, which can be easily verified by the observation of living Prosobranchs in the act of spawning. J. T. CUNNINGHAM.

1 Morrab Terrace, Penzance.

The Natural Prey of the Lion.

WHAT constitutes the natural prey of the lion in his wild state is, I believe, a disputed point. The majority of people, probably, are of opinion that he is extremely fastidious in his tastes; others, again, assert that he will eat almost anything. Certainly, it is only reasonable to suppose that a lion sufficiently under the impulse of hunger will eat "almost anything"!

Years ago I was present on more than one occasion when animated discussions on this point took place between two notable African ecclesiastics—both since dead—Bishop Smythies

and Archdeacon Maples (he was then), both of whom had travelled a good deal in Africa—Maples more especially—and had seen something of the habits of lions.

Bishop Smythies defended the former theory; Archdeacon Maples—a most talented and entertaining man—the latter, saying he had known instances of lions killing porcupines, and adding that he believed the porcupine to be specially endowed with the power to propel his quills into his assailant when so attacked.

At this juncture, Bishop Smythies generally lost patience and declined to continue the argument.

Had Bishop Smythies lived, it would have interested him, as it may interest some of NATURE's readers, to know that in March last, at the Salt Stream, two days' march N.W. of Kibwezi, I shot a fine old lion in whose left fore-paw were deeply buried the tips of three porcupine quills.

These are in my possession at the present time: the longest measures exactly 1 inch; another is almost as long, and measures $\frac{7}{8}$ of an inch. How long he had been afflicted with these painful appendages I could not say—months at any rate, or may be years; since the paw was not inflamed, and from constant friction and pressure in using it the cartilage surrounding the quills had become callous.

There is no immediate reason for supposing that in this case the lion killed the porcupine acting on the impulse of inordinate hunger: the Salt Stream country teems with game—such as rhinoceros, zebra, hartebeeste, gnu, gazelles, and ostriches; it is also just such a country for cover as lions habitually frequent, and *do* frequent in numbers, as may be judged from the fact that in two days I saw them on three occasions.

Leopards, I was already aware, prey freely on porcupines. But this is the first instance which has occurred—in my own experience—of a lion's doing so. RICHARD CRAWSHAY.

Neugia, Kitwi, British East Africa, February 6.

Precipitation of Gold by Charcoal.

IN your "Notes" this week, the use of charcoal as a precipitant for gold from solutions is mentioned as being pretty largely applied in Australia, and that the cause of precipitation is not understood.

I venture to put it this way: that by some process, accelerated no doubt by surrounding physical changes, there is formed within the charcoal carbon *mon*oxide (and also carbon dioxide), which is a precipitant for gold. The difficulty of ridding charcoal of oxygen without chemical combination is well known.

I may mention that I am now using carbon monoxide as an industrial precipitating agent in gold-winning.

JAMES C. RICHARDSON.

19 Claremont Square, London, March 29.

IT is an old idea that carbon monoxide is the real agent in the precipitation of gold from solutions of the chloride by means of charcoal. An objection to Mr. Richardson's suggestion, that the same view may be taken in the case of cyanide solutions, lies in the fact that, according to my own experiments, carbon monoxide does not appear to precipitate gold under ordinary conditions from these solutions.

The main objection, however, to all the theories put forward to account for the precipitation of gold by charcoal is that they are not supported by the results of any published experiments.

THE WRITER OF THE NOTE.

Instincts of Wasps.

PERHAPS it may interest your reviewer of Dr. and Mrs. Peckham's work "On the Instincts and Habits of the Solitary Wasps," to learn that one of the main results in question has been already arrived at in a paper by the late Prof. Schiff, of Geneva, in *Mémoires de la Soc. de Physique et d'Histoire naturelle de Genève*, vol. xxviii., 1882-3. I quote the following passage, as in some way complementary to the observations of Dr. Peckham:

"D'ailleurs, un examen microscopique approfondi du système, nerveux des animaux intoxiqués par les guêpes n'a pas revélé la moindre lésion dans les nerfs et les ganglions de ces animaux."

Freiburg, Badenia, March 18. DAVID WETTERHAN.

CORUNDUM AND ITS USES.[1]

THE three works cited below give much new and valuable information concerning the mode of occurrence, the processes of mining, and the uses of corundum. As the mineral is of growing economic value, and is every day finding fresh applications in the arts, it seems desirable to call attention to some of the facts which are for the first time made accessible to the public in these works. We may exclude from view, for our present purposes, the clear and brightly coloured varieties of corundum, so much prized as gem-stones (ruby, sapphire, &c.), and also the composite material known as emery. The latter substance should be regarded not as a mineral, but as a rock—one in which the mineral corundum is a predominant constituent, though always mixed with magnetite, tourmaline, and many other minerals.

Among the works of which the titles are given below, precedence may be fairly conceded to that which deals with Indian corundum. Corundum is a distinctively Indian mineral; its name is of Indian origin, and its recognition as a distinct mineral species was the result of the study of Indian specimens. The plan, now adopted by the Director of the Geological Survey of India, of republishing the "Manual of Economic Geology" in a series of separate memoirs, each dealing with a particular mineral, or group of minerals, is one which must commend itself to every one as being calculated to furnish us with the most complete and exact information from the pens of the best qualified authorities. It is fortunate that the writing of the memoir on corundum has fallen into the hands of so competent a mineralogist and geologist as Mr. Holland.

The first nine pages of the memoir are devoted to a condensed, but very clear and exact, account of the mineralogical characters of corundum. The next ten pages contain an admirable discussion of the geological relations of corundum. Mr. Holland's studies of the famous corundum-yielding rocks of Southern India have furnished him with much fresh material bearing on the mode of occurrence and association of the mineral. In the work before us only a brief sketch can be given of these, and of the theoretical questions upon which they throw much new light. It is to be hoped that the present short memoir will be followed by detailed accounts of the geology of Salem and other districts in Southern India, where Mr. Holland and several of his colleagues have had the opportunity of re-examining the rocks made known to us by the travels of Leschenault de la Tour, and the petrographical researches of Prof. Lacroix.

The larger portion of the memoir is occupied by detailed accounts of the exact distribution of corundum throughout the Indian Empire, and a discussion of the uses of corundum. In this latter part of the work much valuable information, carefully collected from a number of trustworthy sources, has been brought together; and the reader cannot fail to find much that is new, and also has important bearings on the economic uses and the manufacture of the various varieties of corundum as known in the markets of the world.

While the corundum of India has been sought for from the earliest times for use in grinding gems, and other purposes in which abrasive materials of the greatest hardness are required, the rich deposits of the same mineral in the Eastern United States have only been worked for similar purposes during the last twenty years.

[1] "A Manual of the Geology of India. Economic Geology. By the late Prof. V. Ball, C.B., LL.D., F.R.S. Second edition revised in parts. Part I. Corundum. By T. H. Holland, A.R.C.S., F.G.S. (Calcutta, 1898.)

"Mineral Resources of the United States: Seventeenth Annual Report of the U.S. Geological Survey: Corundum Deposits of the Southern Appalachian Regions." By J. A. Holmes. (Washington, D.C., 1896.)

"Economic Geology of Eastern Ontario: Corundum and other Minerals." By Willet G. Miller. Report of the Bureau of Mines. Vol. vii. Pl. 3. (Toronto, 1898.)

Corundum deposits are known to occur all along the southern flanks of the Appalachian Chain, from the State of New York to that of Alabama, but it is in only a few localities, principally in North Carolina and Georgia, that the corundum has been extracted on any considerable scale. In 1871 attention was first drawn to the deposits in North Carolina as a possible source of gems, and in 1878 mining operations were commenced to extract the abundant corundum of the district as an abrasive material. A great deal of secrecy has been maintained respecting the nature and extent of the corundum industry in the United States; but there appears to be no doubt that since 1878 a steady increase in the output of the corundum mines has been maintained.

The discovery of valuable deposits of corundum in the third of the localities noticed above, that of British Ontario, dates only from 1896. But already there seems to be promise that the counties of Hastings, Renfrew and Peterborough in Eastern Ontario, may, at no distant date, yield large supplies of corundum to the manufacturer.

The Indian corundum is usually found among the gneissose and schistose rocks; the exact conditions under which the mineral makes its appearance will be better understood when the investigations, upon which Mr. Holland has been engaged for some years, are fully published. He has already shown that in some cases the corundum is found in connection with nepheline-bearing rocks, and a precisely similar association has been demonstrated for the corundiferous deposits of Eastern Ontario. The corundum of the Appalachian belt of the United States, however, as shown by Dr. J. H. Pratt, would appear in all cases to occur in the Peridotites (Dunites, Serpentine, &c.), which are intrusive in crystalline schists, and especially in the zones of contact on the outer limits of those intrusive masses.

Corundum, the crystallised oxide of aluminium, has been prized from the earliest times on account of its hardness—which exceeds that of all other natural substances, with the exception of the diamond. In India, blocks of corundum and fragments mounted in tools have been used for grinding, perforating and engraving gems. For general abrasive purposes elsewhere, the rock emery (especially that of Naxos and the adjoining islands and mainland of Asia Minor) has long been preferred to corundum itself. The reason of this is that although emery has a far less "effective hardness," or power of abrading hard materials, than pure corundum, yet the ease with which it can be reduced to powder greatly facilitates its use.

Pure corundum, when freed from its adhering matrix of softer materials (mica, chlorite, &c.), is crushed between rollers and sifted, the "corundum sand" thus formed having far more abrasive power than crushed emery. The chief use of corundum sand is for making corundum wheels; the cementing materials employed in making these wheels seem to be very varied. Shellac alone, or with the so-called "oxidised linseed oil," is one of the commonest materials employed, as in the so-called "red wheels." Silicate of soda is employed in the "silicate wheels," and india-rubber and other substances in the "vulcanite" or "black wheels"; while the cementing material in the "union wheel" is oxychloride of magnesia, and in the "tanite wheel" some form of a so-called "solution of leather," the process of manufacture being kept secret.

Pure corundum wheels are said to be at least twice as effective and durable as emery wheels. Corundum wheels are made in India, with the lac-resin as the cementing material.

Emery and corundum wheels may be regarded as rotary files, whose cutting points never grow dull. They are rapidly replacing files for cutting down metal surfaces, and taking the place of grindstones for sharpening tools. The corundum grains throughout the wheel retain their cutting power, so that it can be worked until quite 90 per cent. of its weight has been worn off, while a file is useless before it has lost 5 per cent. of its weight. It has been estimated that to remove one pound weight of iron with a file costs 2*s.* 6*d.*, while the same amount of work can be done with an emery or corundum wheel in about one-eighth of the time and at one-seventh of the cost. Compared with grindstones in grinding tools, experiments by some English firms show that the cost of the emery wheel is about one-fifth, and the time only one-half of that required by the use of the old grindstone, and at the same time the danger of bursting during rapid revolution, which is such a common accident with the latter tool, is practically abolished.

The corundum wheel is said to be twice as effective as the emery wheel, while its cost is only 15 per cent. more.

It will be seen from these statements that there cannot fail to be a great future for wheels made from corundum and similar materials.

As is pointed out by Mr. Holland, corundum is the richest ore of the valuable metal aluminium. So long, however, as abundant supplies of bauxite (impure hydrated oxides of aluminium) can be obtained, it is scarcely likely that the hard and intractable corundum will be used for the extraction of the metal. The time may, however, come when such a use will be made of the material, which is now almost wholly sought for abrasive purposes.

MULTIPLE VISION.

It is well known that, owing to what is termed irregular astigmatism, a small bright object, for which the eye is not accommodated, often presents a multiform appearance, the number of separate images perceived varying in different cases from about six to fifteen.

Irregular astigmatism, to which every one is in some degree a victim, can be easily demonstrated in the following manner. With the point of a fine needle a very small hole is pricked in a sheet of tin-foil; this is held up to the light, and the hole is looked at with one eye, the other being closed. Even at the distance of most distinct vision—ten inches, or thereabouts—there will probably be a ragged appearance about the perforation, as if it were not perfectly round. But if the tin-foil be brought an inch or two nearer to the eye, the perforation will not seem to be even approximately circular; it will generally assume the form of a little star with six or more pointed rays. The form of the star is not often the same for the right eye as for the left; but if several holes be pricked in the tin-foil, all the stars as seen by the same eye will appear to be formed after the same model, though some may be larger or brighter than others.

If the luminosity of the source of light is sufficiently diminished by screening with a coloured glass, or otherwise, the star will be seen to consist of several distinct images of the hole superposed upon an irregular nebulous patch. Seven such images can generally be perceived—a central one surrounded by six others, but sometimes there may be more. This and other allied phenomena exhibited by a healthy eye are commonly attributed to the fact that the crystalline lens is composed of several sections connected by radial sutures, six or more in number, which occur upon the two surfaces of the lens.

Some observations described in a recent communication to the Royal Society (*Proc. Roy. Soc.*, January 1899) indicate that under certain conditions the number of independent images due to a single luminous point is far greater than could be accounted for in this way; there may, in fact, be several hundreds, and their formation probably arises from the cellular structure of the transparent media of the eye.

In my earlier experiments the luminous object consisted of a small bright disc, but it was soon found desirable to employ a source of light having a more distinctive and conspicuous form than that of a simple circle, and after several trials an excellent object was found in the horseshoe-shaped filament of an electric lamp. The lamp should be dimmed, either by placing coloured glasses before it, or, preferably, by inserting a resistance. An Edison-Swan 50-volt lamp of 8 candle-power has a suitable filament, and may advantageously

Fig. 1.

be connected in series with one or two of the lamps ordinarily used on the circuit. Most electric lamps have looped filaments, and are not so well adapted for the observation.

When the dimmed lamp is looked at from a distance of a few feet through a lens of about 6 inches focal length, held close to the eye, the patch of luminosity formed upon the retina appears to be made up of a crowd of separate images of the filament, some being

Fig. 2

brighter than others, as represented in Fig. 1.[1] When the observer is near the lamp, the number of images is comparatively small; as he retires, it gradually increases, but after a certain distance has been reached the definition of the images becomes impaired, and they can no longer be easily distinguished. The method of observation as thus described may obviously be varied, and, indeed, an experienced observer can put his eye sufficiently out of focus without the aid of any lens.

To assist in analysing the luminous field, an adjustable slit, taken from a spectroscope, was interposed between the eye and the lens. The appearance presented by the filament when the slit was made $\frac{1}{80}$ inch (0·3 mm.) wide, is very well imitated in Figs. 2, 3 and 4, which show the effect with the slit in horizontal, vertical and intermediate positions. The imitation was produced by photographing the lamp by means of a lens covered with two layers of

Fig. 3.

gauze, the one containing 75 meshes to the linear inch, the other 50; a slit $\frac{1}{25}$ inch (1 mm.) in width was placed before the lens.

An attempt was made to count the greatest number of images that could be seen with fair distinctness. The whole of the filament was screened from view except a short portion of one limb, which was viewed from a distance of about 8 feet through a horizontal slit and a lens of 5 inches focus. According to the estimates of

Fig. 4.

several different observers, the number of images was greater than 20 and less than 30 (whence it is calculated that without the slit there would be some 500). Exact enumeration is perhaps impossible, for though at the first glance one receives the impression that the number is quite definite and probably about 25, closer examination shows that it is often very difficult to localise the line of demarcation between successive images.

If the distance between the eye and the incandescent filament is much more than 8 feet, or if a lens of shorter

[1] The photographs, Figs. 1 to 4, are too delicate for satisfactory reproduction. In the originals each picture is easily seen to be entirely composed of separate images of the filament.

focus is employed, the multiple images become blurred and indistinct. The appearance ultimately presented is that of a band of light crossed by a very large number—probably 400 or 500—of hazy dark lines at right angles to its length. These might be produced by some structure in or near the crystalline lens or the cornea composed of elements measuring about $\frac{1}{2000}$ inch in length or breadth.

I do not know of any simple structure sufficiently coarse-grained to account for the images of which 25, or thereabouts, occur in a row. The mesh of a network which would explain these should be about $\frac{1}{125}$ inch (0·2 mm.) in length, and nothing of the kind is, I believe, to be found in the eye. Probably, however, the effect is a composite one, like that of the two pieces of gauze used in photographing the lamp. If light passed through two superposed nets having fine meshes, dark bands would generally be produced, which would take the form of a network of a coarser mesh than those of the nets themselves—possibly much coarser, as would be the case if the two nets were nearly alike in structure.

Shelford Bidwell.

NEW STAR IN SAGITTARIUS.

A CIRCULAR (No. 42) from the Harvard College Observatory, informs us of the detection of a new star in the constellation Sagittarius by Mrs. Fleming, during the examination of the Draper Memorial photographs. The date of appearance is not yet definitely determined, but was either in the latter part of the year 1897 or the early part of 1898. The approximate position for 1900, as found from the Durchmusterung Chart of the region, is

R.A. = 18h. 56m. 12·2s. Decl. = − 13° 18′ 16″.

The star was too faint to be photographed on eighty-seven plates exposed during the period 1888 September 5 to 1897 October 23, even though the last of the plates taken in 1897 showed stars down to the 15th magnitude, the instrument being the 24-inch Bruce telescope at Arequipa. The Nova first appears on eight plates taken in March and April of last year—four at Arequipa with the 8-inch Bache telescope and four at Cambridge, Mass., with the 8-inch Draper telescope, both of these instruments being provided with prisms outside the objectives. It may be added that both the lenses are doublets. The estimated magnitudes are from comparisons with adjacent stars, and are to be regarded as approximate, as the star was away from the centre of plate in several cases. On March 8, 1898, the magnitude is given as 4·7; while on April 29, 1898, it is 8·2.

The Nova has of course been detected from the peculiarity of its spectrum, which consists chiefly of bright lines. The best photograph was obtained on April 19, 1898, with an exposure of sixty minutes, the magnitude of the star then being 8·2. The spectrum, 3 mm. in length, shows the lines H_β, H_γ, H_δ, H_ϵ, H_ζ, H_η, and probably H_θ, due to hydrogen, *bright*. A *broad* band at λ 4643 is also bright, and *narrow* bright lines are present at λλ 4029, 4179, 4238, 4276, 4459, and 4536, these latter appearing to be identical with lines at corresponding positions in the spectrum of Nova Aurigæ. The strongest dark line is at λ 4060. As in the Novæ Persei, Aurigæ, Normæ, and Corinæ, the line H_ϵ is *bright*; while in variables of long period this line is always *dark*, being possibly obscured by the neighbouring broad calcium line H. This difference may serve to distinguish between Novæ and variables. The accompanying dark lines on the more refrangible edges of the bright bands of Novæ Aurigæ, Normæ, and Corinæ are not visible in the spectrum of Nova Sagittarii. The calcium line K is also invisible. In the photograph obtained two days later—1898 April 21—certain marked differences are noted. The broad dark line λ 4060 has disappeared, and a narrow bright line appears at λ 5005, possibly identical with the chief nebula line at λ 5007. The hydrogen lines appear to be narrower and more intense.

Plates exposed at Arequipa on October 7 and 8, 1898, but not yet examined, will furnish important information as to the rate of diminution of the light of the Nova. On the morning of March 13 of this year, Prof. O. C. Wendell examined the star with the photometer at Cambridge, and found that its magnitude was then 11·37. Visual examination showed its light to be nearly mono chromatic, with a faint continuous spectrum, in this respect resembling other Novæ that have preceded it, in having changed to a gaseous nebula. This change had evidently begun at the time of the photograph taken on 1898 April 21, showing the line λ 5005.

It is interesting to note that of the six new stars which have been discovered since 1885, five have been found by Mrs. Fleming during her detailed examinations of the Henry Draper Memorial photographs of stellar spectra.

During the last four hundred years fifteen stars have appeared which may be regarded as Novæ, and, in general, have been found in the vicinity of the central line of the Milky Way, their average galactic latitude being about 11°·2. Nova Andromedæ and Nova Centauri showed no bright lines in their spectra, and, if these be excepted, the average galactic latitude of the remaining thirteen is 9°·0. Of these Nova Coronæ is the only new star with bright lines in its spectrum which has appeared far from the central line of the galaxy, its latitude being 46°·8. If this also be excepted, the average galactic latitude of the other twelve is reduced to 5°·8. It is thus to be inferred that there is some association between the galaxy and the new stars whose spectra contain bright lines, as the probability that such a distribution is due to accident is extremely small.

FRANZ RITTER VON HAUER.

A DISTINGUISHED Austrian geologist has passed away in the person of Dr. Franz Ritter von Hauer, the Intendant of the Royal Imperial Natural History Museum of Vienna. Von Hauer was born in Vienna on January 30, 1822, and received his education partly in that city, and subsequently at the mining academy of Schemnitz. In 1846 he became assistant to Wilhelm von Haidinger, who was then councillor of mines and lecturer on mineralogy in Vienna. Later on, in 1849, when Von Haidinger was appointed director of the then newly-established Imperial Geological Institute, Von Hauer was engaged as geologist, and he took a leading part in the work of the survey, succeeding to the post of director on the retirement of his chief in 1866.

Among his special geological works, those on the Cephalopoda of the Triassic and Jurassic formations of eastern Alpine regions are the most numerous and important; but he contributed other papers and works on mineralogy and applied geology.

His most important general work was that of the geological map of the Austro-Hungarian monarchy, which was issued in twelve sheets, 1867–71, and of which a fourth edition, including Bosnia and Montenegro, was published in 1884. His explanatory pamphlets relating to this great map have been described as "models of concise description," while his general manual of Austrian geology, published in 1875, "is the best guide we have to some of the most interesting parts of Central and Eastern Europe." The remarks quoted were made by Mr. R. Etheridge in 1882, when as president of the Geological Society he forwarded to Von Hauer the

Wollaston Medal, which was then awarded to him by the Council. Von Hauer had been elected a foreign member of the Society in 1871. In 1886 he was appointed Intendant of the Natural History Museum at Vienna, and since 1892 he has been a life-member of the upper house of the Austrian parliament. He died on March 20, aged seventy-seven.

NOTES.

At a meeting of members of the Royal Institution on Monday, it was announced that the Hodgkins Medal, the first gold medal for scientific work ever given by the Smithsonian Institution, has been conferred upon Prof. J. Dewar, F.R.S., in recognition of his researches on the liquefaction of air.

Mr. A. P. Trotter (at present Government electrical engineer for Cape Colony), has been appointed electrical adviser to the Board of Trade, in succession to Major Cardew, who has resigned.

A French warship, upon which experiments in aerial telegraphy will be made, has arrived at Calais, and the experiments will be carried out between different points in the English Channel and the South Foreland. The French Government have under consideration the question of adopting the system generally for use in the navy. It is reported that the Wireless Telegraphy Company have been approached by the representative of a proposed syndicate, which desires to acquire the sole rights of establishing wireless telegraphic communication between England and America.

The Rotterdam correspondent of the *Times* reports that the seventh Dutch Physical and Medical Congress opened on Friday, April 7, at Haarlem. Though it is a national institution the Congress is entertaining a foreign guest, Prof. Ramsay. On Thursday evening, in an address on the merits of Haarlem as a home of science, Prof. Bosscha, the director of Teyler's Museum, mentioned Kirschhuyzen, the humble teacher of mathematics whose manual of algebra was translated into Latin by Newton. Prof. Bosscha, in opening the Congress on Friday, reviewed the progress that science has made in this century, and dwelt especially on the researches of Lord Kelvin. In one of the sections Prof. Ramsay delivered an address on recent researches, and at the end the audience gave him enthusiastic applause.

During the months of March and April a public conference is being held at the Botanical Institute at Rome, under the presidency of Prof. Pirotta, on the Nutrition of Plants.

Dr. L. Buscalioni has set out for a lengthy botanical expedition to Brazil, especially to the little known affluents of the Amazon. The collections will be forwarded to the Botanical Museum at Rome.

We learn from the *Journal of Botany* that Mr. I. H. Burkill has been appointed assistant to the Director of Kew Gardens, and that Mr. C. C. H. Pearson has joined the Kew staff as assistant for India.

We regret to have to report the death of two distinguished diatomists—Surgeon-Major G. C. Wallich, M.D., who died in London on March 31, in his eighty-fourth year, and Count Abbé F. Castracane, of Rome. Dr. Wallich and Count Castracane were, with one exception, the two oldest Honorary Fellows of the Royal Microscopical Society.

Sir William Jenner, who died on December 11, 1898, bequeathed 10,000*l.* to the Royal College of Physicians of London. The bequest will, however, only take effect in default of appointment being made by Lady Jenner of the ultimate residue of the estate, if any, after the principal legacies have been provided.

The death is announced of Dr. P. L. Rijke, of the University of Leyden, at eighty-six years of age, and of Dr. Oliver Marcy, professor of natural history in North-Western University, Evanston, U.S.A.

It is announced in *Science* that the report that Dr. T. J. J. See has been designated Chief of the U.S. Nautical Almanac Office is incorrect.

The Imperial Academy of Sciences, St. Petersburg, celebrates to-day the fiftieth anniversary of the foundation of the central physical observatory.

The London Geological Field Class, conducted by Prof. H. G. Seeley, F.R.S., will commence their annual series of Saturday afternoon excursions on April 22. Full particulars can be obtained from the Hon. Secretary, Mr. R. Herbert Bentley, 43 Gloucester Road, Brownswood Park, N.

The death is announced of Mr. Joseph Stevens, for some years honorary curator of the Reading Museum. Mr. Stevens was a Berkshire man, having been born at Stanmore in that county on April 14, 1818. After qualifying for the medical profession he settled in the village of St. Mary Bourne, in the Test valley between Andover and Highclere in Hampshire. Here he devoted himself largely to archæological subjects, and gave considerable attention also to geology. In 1867 he published, in pamphlet form, "A Descriptive List of Flint Implements found at St. Mary Bourne; . . . with a sketch of the geological features of the upper Test valley, and a list of fossils from the upper and lower Chalk," &c. He was the author of other papers on similar subjects. He died on April 7, at the age of eighty-one.

The Easter dredging expedition of the Liverpool Marine Biology Committee was brought to an untimely end by an unfortunate boat accident in Port Erin Bay. On March 31 dredging and trawling were carried on from the Fisheries steamer *John Fell*, and on the following forenoon the Tanner closing net and the method of pumping plankton from the bottom by means of a hose-pipe were tried on the steamer. On the afternoon of Saturday, April 1, two of the workers in the Biological Station went out to collect surface plankton n a small boat. While hauling in the tow-net when returning, the boat capsized, and both were thrown into the water. One of them (Mr. E. J. W. Harvey, of Liverpool) was picked up by another boat from the Biological Station, but his companion (Mr. Eric T. Townsend, of Manchester) was unfortunately drowned before assistance could reach him. The body was eventually recovered. Mr. Townsend was a student of the Owens College, and was occupying the College work-table at the Port Erin Biological station.

The Belgian Royal Academy has issued its programme of subjects for essays in competition for gold medals of value 600 francs each, to be awarded in 1900. The essays are to be sent to the Secretary before August 1, 1900, each bearing a motto, and written in French or Flemish. Contrary to the usual custom, five subjects instead of three have been selected in each of the two departments of mathematical and physical science and of natural science. The mathematical and physical questions refer to (1) critical phenomena in physics; (2) viscosity of liquids; (3) the carbon derivatives of an element whose combinations are little known; (4) the history and theory of variation of latitude; (5) the algebra and geometry of n-linear forms where $n > 3$. The questions in natural science refer to (1) the geological formations at Comblain au Pont, and whether these are

Devonian or Carboniferous; (2) the physical modifications produced in minerals by pressure; (3) the organisation and development of the platoda; (4) the presence of a nucleus in the Sehizophyta; and (5) the Devonian flora of Belgium.

M. P. VILLARD, writing in the *Journal de Physique* for March, continues his observations on kathodic rays. Among other interesting conclusions, the author is led to the view that hydrogen plays a prominent part in the production of kathodic rays; this view explains the action of these rays in reducing oxides.

M. D'OCAGNE'S system of "abaques" is remarkable for the number of problems it enables the mathematician and the physicist to solve graphically. An interesting application of the method is given by M. A. Lafay in a recent number of the *Journal de Physique*, where Fresnel's laws of reflection and refraction are represented by means of "abaques."

IN a note communicated by M. E. Carvallo to the *Journal de Physique* for March, on Clausius' theorem, the author points out that although abundant proof is given in text-books that for a reversible cycle $\int dQ/T = 0$ the property that this integral is negative for irreversible cycles receives scanty demonstration. The author considers it desirable that this question should be more fully considered in elementary courses than is usually done, and points out that this can best be effected by a more or less detailed consideration of the different transformations which lead to irreversible cycles.

DR. RUDOLF MEWES has published a second edition of his pamphlet on "Licht-, Electrizitäts-, and X-Strahlen," of which the first edition appeared in 1896. The vast literature on Röntgen rays which has accumulated during the past three years has rendered it necessary for the author to restrict his attention to researches bearing on the analogy between Röntgen rays on the one hand and light and electric waves on the other, both in their nature and in their fundamental laws. The author in an appendix also discusses an application of the wave theory to the problem of gravitation.

UNDER the title "Two discharges derived from one condenser," Prof. A. Ròiti, writing in the *Atti dei Lincei*, viii. 1, describes the phenomena produced when a condenser, charged by an electrostatic machine working uniformly, is connected, by means of two pairs of coils, with a Röntgen ray tube on one hand and a spark gap on the other, the two being arranged in parallel. By varying the self-induction of the coils and the length of the sparking gap, the two discharges are made to take place simultaneously, and the intensity of the Röntgen rays is made a maximum; and Prof. Ròiti gives a mathematical investigation of the results observed in his experiments.

IN the *Proceedings* of the Philosophical Society of Glasgow, Dr. W. J. Fleming describes a simple and inexpensive method of localising with Röntgen rays. This, like other methods, is based on the measurement of the distance apart at which two images are produced by rays impinging on the object in two directions at known angles to each other. The advantage of the stand described by Dr. Fleming is that it enables the tube to be rotated on two axes crossing at the centre of the anode, the point from which the rays proceed. In this way it is possible to make the slanting surface of the anode face in any direction in which it is desired to project the rays, without affecting its position; while the change of position of the tube can be effected separately by moving the supporting stand, and can be readily measured.

THE annual report of the Institute of Jamaica states that an almost complete series of the thirty-five known species of Jamaica actiniaria, collected by the curator, Mr. J. E. Duerden, has been placed on exhibition. A large series of sponges, contributed by the Caribbean Sea Fisheries Development Syndicate, constitutes almost the beginning of the local collections in this group. One compact massive sponge is two feet in diameter. A 3 to 5 per cent. solution of formalin has now been employed for over two years as a preservative fluid for fish, cœlenterates, holothurians, &c., and has proved satisfactory, preserving the natural form and colours of the animals better than alcohol. A polished slab of mahogany, four feet in diameter, has been added to the collection of woods, and illustrates the irregular increase in thickness of tropical trees, as compared with the regular annular rings in dicotyledons of temperate parts. New types and many duplicate examples of relics of the aboriginal Indian inhabitants continue to be received and added to the already large collection on view and in store cases.

MESSRS. E. H. HALL AND C. H. AYRES contribute to the *Proceedings* of the American Academy of Arts and Sciences a determination of the thermal conductivity of cast iron. In their experiments a disc of cast iron was coated with an electrolytic deposit of copper on its two faces, and the difference of temperature of the faces recorded by galvanometric readings depending on the thermo-electromotive forces of the two couples thus formed. Water at different temperatures was made to flow across the two copper faces, and the total flow of heat measured by comparing the differences of temperature between the water entering and leaving the vessels. The thermal conductivity of the cast iron used was found to be about 0·1490 at 30° C., its temperature coefficient being about −0·00075 between 20° and 75°. The electric conductivity of this sample was about 112,200 C.G.S. units, its temperature-coefficient between 17° and 67° being about −0·00118. The method used is thought by the authors to be capable of giving better results than have yet been obtained by it.

IN these columns frequent reference has been made to Dr. Folgheraiter's researches on the magnetisation of ancient vases, from which the author long ago advanced the hypothesis that the magnetic dip had changed sign within historic times at the places where these vases were made. The evidence on this point, derived from examination of Grecian vases in the Museums of Florence and Syracuse, forms the subject of the most recent paper of the series published by Dr. Folgheraiter in the *Atti dei Lincei*, viii, 5. Some of the vases, owing to the ornamentations and projections above their mouths, could only have been placed in the furnace in an upright position, and although the presence of these projections rendered it necessary for Dr. Folgheraiter to restrict his observations to the bases of the vases, the *sign* of the magnetic dip, if not its magnitude, was readily determinable. Dr. Folgheraiter concludes (1) that at the commencement of the period of fabrication of the Corinthian vases and of the Attic ones with black figures on a red background (seventh century B.C.), the magnetic dip in Greece was austral; (2) that shortly afterwards, perhaps at the beginning of the sixth century, while Corinthian vases were still being made, the magnetic dip was nearly zero, and then became boreal; (3) that at the end of the period of fabrication of the Attic vases (about 400 B.C.) the magnetic dip was boreal and amounted to about 20°.

AMONG the latest results obtained by Drs. B. Grassi, A. Bignami and G. Bastianelli, regarding the propagation of malaria by mosquitos, the following conclusions are stated in their paper in the *Atti dei Lincei*, viii. i. (1) The hæmosporids of malaria undergo in man the well-known life-cycle characterised by the long duration of the amœboid phase and the absence of incapsulate stages; in this cycle they are reproduced an indefinite number of times, but also give rise to

forms which in man remain sterile. Such forms on entering the intestine of the perfect insect of *Anopheles claviger*, are developed as typical sporozoa which form an enormous number of sporozooids, and these, accumulating in the salivary glands of the mosquito, return to man in the act of puncture. They may, however, instead undergo another life-cycle giving rise to spore-formation. (2) The development of malarial hæmosporids in the body of the mosquito has been demonstrated for the parasite of autumnal fever and for that of ordinary fever. (3) While the transference of the hæmosporids from man to mosquitos and *vice versa* has been abundantly proved, it is still an undecided point whether the parasites are transmitted from mosquitos to their progeny.

IN the *Journal of Conchology* for April 1899, Mr. L. St. G. Byne describes a series of investigations undertaken by him, at the instigation of Mr. J. Cosmo Melvill, on the corrosion and consequent deterioration of marine shells in public collections. This corrosion Mr. Byne is led to attribute to the action of butyric acid upon the calcium carbonate of the shells. The butyric acid was derived originally from the decay of portions of the animal left in the shells. A subsidiary cause is the action of acetic acid, formed by the fermentation of the gum used in attaching the shells to tablets. The white powdery substance upon the surface of the affected shells consists of calcium butyrate, mixed in some cases with a little calcium acetate. Mr. Byne thinks that, in all probability, treatment with corrosive sublimate solution will prove an effectual remedy. We would suggest that Mr. Byne's conclusions may have an important bearing on another question, namely, the permanency or otherwise of microscopic preparations of foraminifera.

THE *Comptes rendus* of the Paris Academy of March 27 contains a notice, by M. Léon Teisserenc de Bort, of three unmanned balloon ascents made under his directions on March 24. One of the balloons was despatched from his observatory at Trappes at 8h. 30m. a.m., in clear weather, and with a light north-west wind, and fell at Trèves (in Rhenish Prussia); the instruments have not yet been returned. Another was sent up near Limoges at 9h. 27m. a.m., in cloudy weather, with moderate N.N.W. wind, and occasional snow-squalls. It fell at Péroles, after a flight of thirty-seven miles, having attained an altitude of about twenty-eight thousand feet; the lowest temperature recorded was $-47^{\circ}{\cdot}2$, the temperature on the ground being $32^{\circ}{\cdot}5$. In order to determine the influence of the sun's rays on the temperatures recorded, one of the balloons was despatched from Trappes (before sunrise) at 3h. 45m. a.m. This fell about seventy miles in an east by south direction. At the above altitude a temperature of $-61^{\circ}{\cdot}4$ was recorded, the temperature on the ground being $26^{\circ}{\cdot}6$.

WE have received from M. A. Lancaster, the director of the Belgian Meteorological Service, a very interesting sketch of the climate of the Congo, abstracted from the *Annuaire* of the Royal Observatory of Belgium for 1899, and chiefly based upon a work entitled "Le Climat du Congo," by A. Lancaster and E. Meuleman, published in 1898. In our latitude temperature is the principal element which determines the character of the seasons, but in the Congo State temperature is relatively uniform throughout the year, the principal element being rainfall, the frequency and amount of which are very marked during some months, while in others rain completely fails. In the equatorial zone, the mean temperature in the afternoon during the year is generally about 86° and about 68° during the night, with but slight variation from one day to another. The rainy season commences in the early part of October, and ends about the middle of May. In proportion to the distance from the coast and to the proximity of the equator, the wet and dry seasons are less marked, and rain falls with variable intensity throughout the year. Generally speaking, the rainfall of the Congo is nowhere exceptional. Thunderstorms are very frequent in the interior of the State; in the equatorial regions they occur at all seasons, while more to the south and in the west they only take place during the rainy season.

THE Chicago Health Department are to be congratulated on the results which they are able to publish attending the use of diphtheria antitoxin in combating diphtheria. During a period of forty-one consecutive months, 4000 cases of "true diphtheria" were treated with a mortality rate of less than 6·8 per cent., whilst within the last four months still greater success has followed the work of the department, for 418 cases have been treated with a mortality of less than 4·8 per cent. In the three years following the introduction and use of the antitoxin, the department record a decline in deaths from diphtheria of 43 per cent., compared with the death rate from this disease registered for the three years previous to the use of antitoxin.

THE *Journal of the Society of Arts* contains in one of its recent numbers the report of the lecture given before the Society by Mr. H. A. Acworth, on leprosy in India. In the discussion which followed, a warm tribute was paid to the author for the splendid work which he carried out in starting, entirely through his own efforts, a magnificent leper asylum on the outskirts of Bombay at Matoonga. As Lord Onslow (who presided) justly stated, "after mature consideration, the Government of Bengal and the Supreme Government of India had adopted the recommendations which Mr. Acworth was th first to bring into practrice, viz. the segregation of lepers. Opinion is still divided as to the wisdom of this policy in com bating leprosy, but there is no doubt that Mr. Acworth's ex periment has been attended with success. To all interested in this important subject, the paper in question contains a mass of interesting information, as well as statistics culled from very various sources.

THE University of the State of New York has just issued, as *Museum Bulletin* No. 19, "A guide to the study of the geological collections of the New York State Museum," by Dr. Frederick J. H. Merrill, director and state geologist. The bulletin aims to supplement the collections with such general information as cannot be given by cabinet specimens, and to direct visitors to trustworthy sources for more detailed information. For this purpose it places within the reach of students a brief synopsis of the geology of the State, and shows by photographic illustrations the exact appearance of many typical exposures. After a general introduction, follow sections dealing with the geologic formations of the State, economic geology, suggestions for study under the heads of geological text, reference-books and field work, and the origin of the museum. The bulletin, which may in fact be regarded as an introductory text-book of geology illustrated by local examples of geological structures, contains 162 pages of text and 119 plates, and is sent post paid by the University for forty cents. Teachers of science in the colleges and schools of the State will doubtless appreciate the efforts of Dr. Merrill and his associates to extend the usefulness of the museum and increase the interest in the collections.

A CAREFUL examination of the rude stone monuments of Japan, and of the sepulchral chambers termed "dolmens," has led Mr. W. Gowland to conclude (*Transactions and Proceedings* of the Japan Society, vol. iv. part iii., 1899) that they were built by the ancestors of the present Japanese. The aboriginal inhabitants were apparently the Ainu, who occupied the whole country until they were gradually driven back to the north by a more powerful race. Whence came the invaders from whom

the present Japanese have descended is not known, and the dolmens afford little information upon this question. No dolmens have been found in China, and those which occur in Korea differ entirely from those in Japan. In fact, Mr. Gowland points out, it is not until, in passing westwards through Asia, the shores of the Caspian Sea are reached, that dolmens similar to the Japanese kind are found; and for more closely allied forms it is necessary to go yet further to Western Europe. The approximate date of the end of the Dolmen Period is regarded as lying between 600 and 700 A.D., and of its beginning about the second century B.C. To sum up, Mr. Gowland shows "that the period during which the dolmens were built in Japan was characterised, from its beginning to its close, by a well-developed civilisation and a culture which had advanced far beyond the limits of barbarism, and was, in fact, the birth-time of the ornamental arts; that the builders of the dolmens were the ancestors of the present Japanese; that during this period the clans of the race had driven out the aborigines from the richest portion of the country, had become a settled and united people, and made great progress in both the arts and industries."

"The Permocarboniferous Fauna of Chitichun, No. 1," forms the subject of a memoir by Prof. Carl Diener, recently published by the Geological Survey of India in the Himalayan fossil series of Palæontologia Indica. The fossils described occur in the white limestone which forms the main mass of the peak Chitichun (17,740 feet) in the Tibetan area between the Laptal ranges and the head of the Dharma valley. They represent altogether forty-eight species, among which brachiopods, numbering forty species, far predominate, both in species and individuals, and comprise five-sixths of the entire fauna. With regard to the general character of the fauna, Prof. Diener sums up his views as to the stratigraphical position of the Chitichun limestone as follows:—"The Chitichun limestone is approximately homotaxial with the upper division of the Productus limestone in the Salt Range. It probably corresponds in age to the permocarboniferous horizon (Artinskian stage) in Russia, but the description of the brachiopods from the Fusulina limestone of Sicily must be awaited for, before it is possible to decide whether it does not hold a slightly higher position in the stratigraphical sequence than the Artinskian deposits."

We have received the second edition of Dr. W. B. Phillips' monograph on iron making in Alabama, published by the Geological Survey of that State. It contains a general description of the ores, fluxes, and fuels used, together with some particulars of the manufacture. The first edition was issued in 1896, and did much to further the development of the iron industry of the State. Since then the blast furnace practice has not materially altered. The same soft and hard calcareous hæmatites and brown ores are used, and the same coke. The use of dolomite as flux has steadily increased. The cheap soft red ore is becoming scarcer, and consequently new deposits of rown ore have been opened. The coke industry shows some notable advances. A complete coal-washing plant, with a capacity of forty tons an hour, and a plant of 120 Semet-Solvay by-product coke ovens have been erected. In connection with the making of steel, the author gives a full description of the manufacture of basic iron in Alabama, and details of the cost of making pig-iron. The lowest cost reached was 23*s.* per ton. Indeed the figures given clearly show that the cheapest pig-iron made in the world is made in Alabama; and the exportation of 218,633 tons to England and the continent during 1897, as against 65,000 tons in 1896, shows the importance of this fact in the development of outside markets for Alabama iron.

Messrs. Dulau and Co., of Soho Square, have issued an eight-page catalogue of books and papers on Fossil Botany.

Mr. Clement Reid has in preparation a work on "The Origin of the British Flora," which will shortly be published by Messrs. Dulau and Co.

Mr. R. Bullen Newton and Mr. Richard Holland contribute to the *Annals and Magazine of Natural History* for March an account of some Nummulites, Orbitoides, and other Foraminifera from Eocene and later Tertiary strata in Borneo.

The sixth volume of "A System of Medicine," edited by Prof. Clifford Allbutt, F.R.S., was published on Tuesday by Messrs. Macmillan and Co., Ltd. The subjects dealt with are diseases of the circulatory system (continued), diseases of muscles, and diseases of the nervous system. Prof. Welch's contribution on thrombosis and embolism, which was not received in time for vol. v., appears in the new volume. We propose to deal with these and succeeding volumes when the work is complete.

A dainty little monthly magazine of photographic information has just made its appearance under the title of *The Photo-Miniature*. It is edited by Mr. John A. Tennant, and published by Messrs. Tennant and Ward, New York (London: Dawbarn and Ward, Ltd.). A survey of the progress of photographic optics, so far as it bears upon modern lenses, forms the greater part of the first number of the magazine; the remaining pages consisting of a digest of photographic information.

The "Handbook of Jamaica" for 1899, comprising historical statistical and general information concerning the island, compiled by Messrs. T. L. Roxburgh and J. C. Ford, has been published by Mr. Edward Stanford. Among the events of 1898 mention is made of the establishment, already announced in these columns, of a West India Weather Service in connection with the Government observatories and stations in the Unied States and several islands in the Carribean Sea.

The third memoir on the materials collected on the atoll of Funafuti has been published by the Australian Museum, Sydney. Mr. Thomas Whitelegge describes the Hydrozoa, Scyphozoa, Actinozoa, and Vermes in the collection; and Mr. Charles Hedley describes the Molluscs. In his introductory remarks, he subjects British conchologists to criticism for neglecting anatomical material in order to discover new species. "As a consequence," he says, "of the devotion of the London school to the study of the Pacific fauna, we have a great mass of involved synonomy, inadequate descriptions, poor figures or none, crude classification, and total neglect of soft anatomy." Owing to pressure of museum duties, Mr. Hedley has been compelled to omit various inquiries on anatomy and other related matters from his own report; and, with the exception of brief notes on geographical distribution, he restricts himself to the mere systematic treatment of the species.

It has been known for some time that the transition temperature, or "melting point," of crystallised salts should be constant for pure materials; but prior to the researches of Messrs. T. W. Richards and J. B. Churchill, it was not realised that this constancy was sufficient for standardising thermometers. In these experiments, which are published in the *Proceedings* of the American Academy of Arts and Sciences, a complete study was first made of sodium sulphate, the transition temperature of which was found to be remarkably constant at 32°·484 C. on the mercury thermometer scale, or 32°·379 C. on the hydrogen scale. These results were then extended to eight other salts, the preliminary figures for which are given ranging from 19·7 for sodium chromate, $Na_2CrO_4.10H_2O$ to 78·0 for barium hydroxide, $Ba(OH)_2.8H_2O$. Commenting on the suggestion by Meyerhoffer and Saunders to use such baths for securing constant temperature during determinations of electrolytic con-

ductivity and similar measurements, the authors think that the Ostwald thermostat bath is still the safest and most convenient appliance for preserving a constant temperature in the laboratory, the baths of "melting" crystals finding their greatest use in the standardising of thermometers at fixed points.

The additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♂), from India, presented by Mr. David M. Greig; two Western Pin-tailed Sand Grouse (*Pterocles pyrenaica*) from Spain, deposited; four Black-tailed Hawfinches (*Coccothraustes melanurus*) from Japan; a Lapwing (*Vanellus vulgaris*), European, purchased.

OUR ASTRONOMICAL COLUMN.

Comet 1899 *a* (Swift).—The unfavourable conditions in England appear to have prevented any observations of this comet, but on the continent it has been frequently seen. From a detailed list of all the recorded observations given in *Ast. Nach.* (Bd. 149, No. 3554), we see that the reported presence of a central condensation is confirmed. Most of the observers agree in estimating the magnitude as about 6·5, or just visible to the naked eye. Prof. Max Wolf says that it was quite bright in the finder, and easily seen with the naked eye when guided to the correct place by the telescope. With a 6-inch telescope a short tail was distinctly visible.

The comet is now very near the sun, but under favourable conditions may possibly be seen with the help of the following extended ephemeris:—

0h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′	Br.
April 13	1 19 36	+ 9 36·7	3·6
14	15 8	10 15·4	3·7
15	10 41	10 54·0	3·5
16	6 18	11 32·4	3·4
17	1 2 0	+12 10·8	3·3

In the beginning of May, however, it is likely that the comet will be easy of observation in the early morning, as it will rapidly recede from the sun after perihelion passage.

Tuttle's Comet (1899 *b*).—The previous ephemeris given was based on data obtained in 1885; but successful observations, obtained at Heidelberg, Lick and Konigsberg, have enabled Herr J. Rahts to recompute the elements and furnish a more accurate ephemeris, which he has communicated to *Ast. Nach.* (Bd. 149, No. 3555).

Elements.

T = 1899, May 4·5 Berlin Mean Time.

$$\left.\begin{aligned} M &= 359°\ 59'\ 46''\!\cdot\!7 \\ \pi &= 116\ 29\ \ 3\cdot0 \\ \Omega &= 269\ 49\ 53\cdot6 \\ i &= 54\ 29\ 16\cdot3 \end{aligned}\right\} 1900\cdot0$$

$$\phi = 55\ 15\ 23\cdot7$$
$$\mu = 259''\cdot6234$$

Corrected Ephemeris for 12h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″	Br.
April 13	3 43 27·7	+19 35 52	
14	47 3·7	19 11 13	1 71
15	50 39·2	18 46 17	
16	54 14·0	18 21 5	
17	57 48·2	17 55 37	
18	4 1 21·7	17 29 54	1·77
19	4 54·5	17 3 55	
20	8 26·6	16 37 42	
21	11 58·1	16 11 14	1·80

New Star Catalogue.—The eighth volume of the "Astronomical Observations and Researches made at Dunsink," the observatory of Trinity College, Dublin, contains a catalogue of the mean places of 1101 stars, together with the separate results of 4022 observations of right ascension and 3999 observations of declination, the range of declination being from - 28° to + 80°.

The observations were made with the Pistor and Martin's meridian circle by Mr. Charles Martin, under the direction of Prof. A. A. Rambaut, then Astronomer Royal for Ireland, during the period 1896, March 16, to 1897, July 17. All the places are brought up to epoch 1900, and the probable error is about ± 0·0328s. in R.A., and ± 0″·480 in Decl. A useful feature of the catalogue is the inclusion of the corresponding numbers denoting the various stars in other catalogues in vogue, viz. Bradley's, Piazzi's, and the B.A.C., and various others, so that cross references are readily seen.

The Sun's Heat.—Mr. A. S. Chessin, in a communication to the *Astronomical Journal*, vol. xix. No. 456, relating to Dr. See's article in *Ast. Jour.*, No. 455, noticed on p. 350 of the current volume, writes as follows:—

"Allow me to observe with regard to Dr. See's 'remarkable' law, which he discusses at length in the last number of the *Journal*, that it is derived by the author with a superb neglect of the principles of thermodynamics. The last stage of the 'proof' is especially curious, as the assertion that T_0 must be multiplied by $\frac{R_0}{R}$ in order to preserve the equilibrium, is nothing else than an assumption of that very 'law' which Dr. See proposes to derive."

ALLOYS.

The fifth Report, by Sir William Roberts-Austen, to the Alloys Research Committee of the Institution of Mechanical Engineers contains some details of much scientific interest. The system of taking cooling curves of metals and alloys, originated by the author of the Report, is now well known, but in the present Report he has indicated a method for obtaining curves of extraordinary delicacy. An ordinary thermo-junction of platinum and platinum iridium wires is placed within the mass of metal which is heated in a vacuous tube, and allowed to cool from a bright red heat. The result, in the case of iron, is

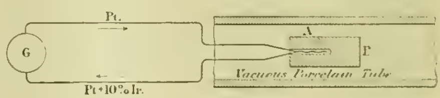


Fig. 1.

that as the mass cools down there are several points at which heat is evolved. In the curve of iron of a high degree of purity only two such points have hitherto been detected, one at about 890° and the other at 760°. Both of these have been supposed to represent allotropic changes in the metal, and the lower one (at 760°) is that at which the magnetic properties of the iron change. In ordinary cooling curves, however, both these points have been indicated by little more than a change in direction of the curves. By adopting the following method curves of great delicacy have been obtained, and the result is that the old

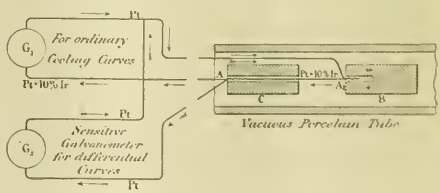


Fig. 2.

changes in direction of the curves in the case of iron, have been developed into large prominences and, moreover, new points in the cooling curves, have been discovered.

The following is the new method, of which a very brief description will be sufficient. In the ordinary method, the twisted end of the thermo-junction A (Fig 1) is placed in the heated mass of metal B under examination, and its free ends are connected with the galvanometer G. In the new method (Fig 2) two thermo-junctions, A and A_1, are employed. One of these

is placed in the piece of metal B, and the other in a compensating piece of copper platinum of fire-clay C. A sensitive galvanometer G_2, connected to both thermo-couples, measures on a large scale the difference between the temperatures of B and C, and magnified records of the evolutions of heat in B can thus be obtained, which are not affected by the general fall of temperature of the system The actual temperature of the piece of metal B is simultaneously registered by the less sensitive galvanometer G_1 in the usual way. In the new method, therefore, the heat lost by the cooling mass of metal B (Fig. 2) is compensated or balanced by the heat lost by a mass of platinum C. The result is, that the effect on the galvanometer G_2 of any evolution of heat in the cooling mass B is greatly augmented. The heat suddenly evolved by the mass of iron or steel B, which is liable to molecular change, is, as has already been indicated, not masked by the fact that the mass is itself rapidly losing heat, as the temperature of the entire system does not affect the sensitive galvanometer, and the heat which is evolved by the mass B is free to make itself felt. Hence the curves recorded by its mirror possess extraordinary sensitiveness. In the Figs. 1 and 2 the arrows show the direction of the currents. Those with feathers indicate the direction of the current which is due to the difference of temperature. This difference is caused by the excess of heat in the iron B, as compared with the platinum C. The featherless arrows show the direction of the current through the unsensitive galvanometer G_1, which records ordinary cooling curves.

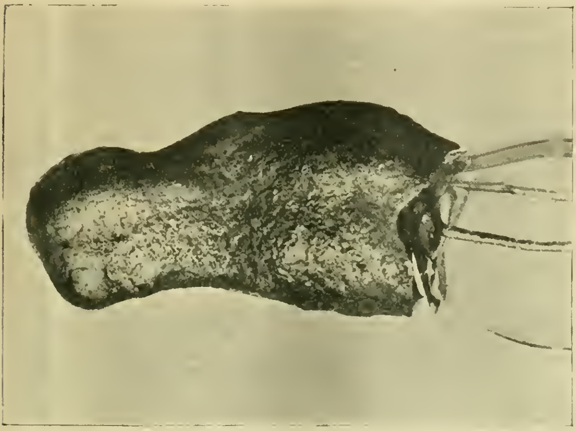


FIG. 3

Reference to a special case, furnished by the cooling of electro-iron from a white heat, will serve to make this clear. Electro-iron was deposited on a thermo-junction protruding from a glass tube into which the wires were fused. The iron was deposited from a solution of ferrous chloride which had been purified with scrupulous care, the anode being a plate of electro-iron. The iron so deposited weighed five grammes, and its appearance, magnified four diameters, is shown in the accompanying Fig. 3.

It was then arranged as shown in Fig. 2, and placed in a porcelain tube glazed inside and out and rendered vacuous by the aid of a mercurial pump which also enabled the gas evolved from the iron to be collected. Hydrogen was freely evolved as the portion of the tube containing the iron was gradually heated; but, although the evolution of gas never absolutely ceased, the amount of hydrogen delivered by the mercurial pump with which the porcelain tube was connected was very small when the iron attained a temperature of some 1300° C. A cooling curve of this iron after four successive heatings is shown in Fig. 4, on $\frac{1}{3}$ of the actual scale it was recorded, and it will at once be evident that in this curve at least three hitherto unobserved points are revealed. These points occur respectively at 580°, 487°, and 261°. The coordinates are, as usual, time and temperature, but the temperature represents on a large scale, molecular evolutions of heat, and not the temperature of the mass under examination.

There is at A the point at 1130° C. Then at B there is the ordinary Ar. 3 of Osmond, which in this case occurs, not as in mild steel at the normal temperature of 850° C., but at 895° C. When the mass continues to cool down there is, as it was anticipated there would be, the point Ar. 2, which in this case occurs at 770° C. The carbon point Ar. 1 could not be expected to occur in iron of so high a degree of purity, and it does not exist: but there is evidence of evolution of heat at a point which is between 550° and 600° C. It is difficult to fix this point accurately, it seems to vary somewhat in successive curves. The next point, at which heat evolved, is a new one of extraordinary interest. It occurs between 450° and 500° C., and there is evidence to show that it is connected with the retention of hydrogen by the mass of iron, even though it had been heated to 1300° C. Finally there is a small point at 270° C., that is, at a temperature of no less than 400° C. below redness.

The significance of these new points which, seem to be connected with the retention of hydrogen by the iron, though they may be true iron points, revealed by the presence of hydrogen, is to some extent considered in the Report. All that need be pointed out here is, that it is important to have obtained a new and delicate method of recording molecular changes which take place in metals and alloys as they cool down from the fluid state to the ordinary temperature.

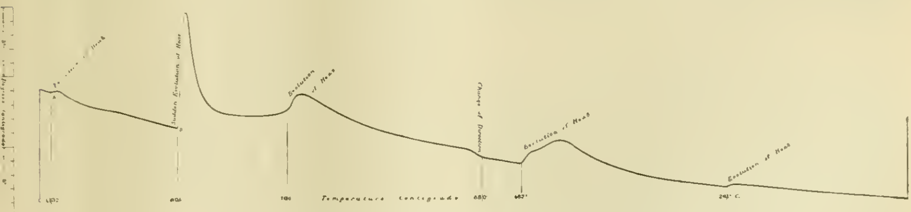


FIG. 4.—Photographic Record ($\frac{1}{3}$ actual size) of the Cooling of Electro-Iron.

By the aid of a long series of such curves Sir William Roberts-Austen has laboriously investigated the carburised-iron series of alloys, which are usually known as steel and cast iron. He shows that they behave exactly as certain saline solutions do, and he has thus afforded a basis for much of the hitherto somewhat obscure procedure in the industrial treatment of iron and steel.

A TREATISE ON SPINES.

A SERIES of papers upon "The Origin and Significance of Spines: a Study in Evolution," contributed by Dr. C. E. Beecher to the *American Journal of Science* from July to October last, has now been distributed by their author in a collected form. There are 80 pages in all, with 73 text illustrations, tables, and a plate delineating leading types of Radiolarian spines after Haeckel. Under the head of "spines" there are dealt with objects between and including "the modified hairs of the *Echidna* and Porcupine," and "the projecting rays and processes of Radiolaria"; movable and fixed forms are alike passed in review, horns and antlers come in for consideration, and only such "spines" appear to be disregarded as are "distinctly internal structures."

The author has been at immense pains to bring together all that is known concerning the nature, origin, laws of growth and limitations of spines, not excluding those met with in the vegetable kingdom; and while, in arranging in an orderly manner this vast accumulation of facts, he has done a good service, we venture to think that the utility of his essay is, to a large extent, marred by the too sudden diversion into side topics which at times appear to us irrelevant. The "law of variation," according to Cope; that of "multiplication of effects," according to Herbert Spencer; the principle of "localised stages of growth," by Jackson; of "reproductive divergence," by Vernon; with "sexual selection," and other supposed laws and heresies, are all in turn called in for comment and consideration. The author so flits about among extremes concerning both organs and doctrines under review, that the reader is often at a loss to discover his views and arguments, and at what he is sometimes aiming. Of all his theses, that which he seems to us to have best substantiated is expressed in his concluding remark that "after attaining the limit of spine differentiation spinose organisms leave no descendants, and . . . that out of spinose types no new types are developed." The subject of "spines" is a notoriously fascinating one upon which much has been written. On perusal of the excellent list of references which accompanies the papers, and comparison with the text, the author appears to us to have exercised too little discrimination in his reading, and to have been too prone to accept much which he found in print. Some of his allusions to the fishes and the desert plants appear especially open to this objection. His reputation is now so well established among working zoologists, in connection with his recent magnificent investigations into the phylogeny of the Brachiopoda and the structure and systematic position of the Trilobites—achievements of which even Yale College Museum may well be proud—that his present series of papers will be widely read. While we are profoundly thankful to him for having collected together and arranged in a workable form so instructive an amount of detail, we doubt if some of his conclusions will prove any more convincing to the majority than those which three years ago led him to a belief in the so-called Protaspis larva.

FOSSIL JELLY-FISH.

AN elaborate work on Fossil Medusæ, by Mr. C. D. Walcott, forms the thirtieth volume of the Monographs of the United States Geological Survey. The attention of the author was first directed to the occurrence of certain siliceous nodules, known as "star-cobbles," in the Middle Cambrian shales of Alabama; and after coming to the conclusion that these nodules contained fossil Medusæ, he was led to extend his researches to all the known fossil forms. Among these some had been recognised in Sweden by Nathorst, and in Bavaria by Haeckel; and the full record embraces forms from the Cambrian of the United States, Sweden, Russia, and Bohemia; from the Permian of Saxony; and from the Jurassic of Bavaria.

The author points out that, under certain conditions, when a Medusa is overwhelmed by muddy sediment, it may retain its shape sufficiently long for the sediment to solidify and make a mould of its external form. Plaster-casts of certain jelly-fish may in some instances be readily obtained. The most favourable conditions for the natural preservation of a Medusa appear to be by burial and rapid consolidation of sediment beneath water; but the author observes that not one in a hundred of the fossil specimens, shows traces of any structure within the body, and, so far as is known, the particularly favourable conditions required "were confined during geologic time to the vicinity of the spot in the Cambrian sea that is now occupied by the township of Cedar Bluff, Cherokee County, Alabama." There the nodules with Medusæ occur in finely laminated shales, and much of the silica forming the nodules appears to be original, and derived from the solution of siliceous organisms. The Medusæ lived in relatively shallow water, and were quickly overwhelmed and buried in a siliceous mud that was subsequently consolidated to form a siliceous shale. The silica, which forms a large portion of the shale, was probably derived from detrital quartz.

The author discusses the relation of the Medusæ to the Sponges, and more especially of the Middle Cambrian forms; and he then proceeds to describe the various species, which are illustrated in forty-seven plates. These figures will prove of considerable interest to geologists; they serve to draw attention to many curious and hitherto problematical structures; and may lead to more precise information with regard to their mode of occurrence. There appears to be no doubt that some of the forms, even of Cambrian age, are true Medusæ; and the author believes that at this early period, if not in pre-Cambrian times, the acraspedote Medusæ were mainly differentiated. He remarks, however, that we have yet much to learn about the medusiform ancestors of the Hydrozoa.

SEASONAL DIMORPHISM IN LEPIDOPTERA.[1]

I HAVE thought this to be a suitable subject for my address, because it is not only of high interest as a remarkable phase of variation, but has also of late years been brought prominently to notice by the researches of two groups of entomological observers; firstly, those who, like the pioneers, G. Dorfmeister, W. H. Edwards and August Weismann, have experimentally studied the effects of high and low temperatures artificially applied to lepidopterous pupæ of European or North American species; and secondly, those who have noted the seasonal changes in butterflies occurring naturally in various tropical and subtropical regions, and have in some cases reared one seasonal form of a species from ova deposited by the other. The earlier temperature experiments in Europe and North America were long in advance of the observations on seasonal dimorphism in tropical countries, the latter indeed being the natural outcome of the former. It may prove not uninteresting if I briefly pass under review the published memoirs relating to both sets of observations, but, as regards the temperature experiments, limiting my remarks almost exclusively to those relating to seasonally-dimorphic species.

No doubt many of us remember with what interest we welcomed Weismann's able treatise[2] published twenty-three years ago, whether in the original or in the English edition (translated by Prof. Meldola) issued in 1882. The cases known to Weismann, and described in this memoir, were not numerous; he calls special attention to six European cases (*Araschnia levana*, *Lycaena amyntas*, *L. agestis*, *Chrysophanus phlaeas*, *Pieris napi*, and *Euchloe belia*), and to three North American (*Phyciodes tharos*, *Grapta interrogationis* and *Papilio ajax*), the latter known to science through the investigations of W. H. Edwards, the well-known monographer of the butterflies of North America, whose experiments and results[3] are republished with additions as Appendix II. to Weismann's essay. In the phenomenon of seasonal dimorphism Weismann recognised, as two prominent factors in the possible *direct* influence of the varying external conditions of life, temperature and duration of the pupal period; and his experiments with *Araschnia levana* and *Pieris napi* were accordingly carried on with the view of ascertaining whether the dimorphism exhibited by those species could be traced to the direct action of those factors. In the case of *A. levana*, he first subjected the pupæ obtained from eggs laid by the winter form, immediately after pupation, to artificial low temperatures, and the result was that, by exposure to temperature of 0°–1° R. for four weeks, three-

[1] An address read before the Entomological Society of London at the annual meeting on January 18, by Roland Trimen, F.R.S., President of the Society.

[2] "Studien zur Descendenz-Theorie. I. Ueber den Saison-Dimorphismus der Schmetterlinge," 1875.

[3] *Canadian Entomologist*, vii. p. 236 (1875), and ix. p. 69 (1879).

fourths of the pupæ produced, not the summer form *prorsa*—as under natural conditions they would have done—but the intermediate form *porima* (extremely rare in nature), three of these being very nearly the pure winter form *levana*. Increasing the period of exposure to cold to eight weeks did not materially add to the extent to which the summer form was lost and the winter form substituted. The converse experiment, frequently repeated, consisted in placing in a hot-house (temperature 12°–24° R.) immediately after pupation, pupæ from eggs laid by the August brood of the summer form, *prorsa*; but here the artificial temperature had little or no effect, all, or nearly all, the pupæ hibernating, and emerging in the following spring as the pure winter-form *levana*. This latter result led the author to the opinion that cold and warmth could not be the *immediate* causes of a pupa emerging in the *prorsa* or *levana* form; and that the explanation of the facts seemed to be (*a*) that the winter form *levana* is the original type of the species, seeing that it was found possible to make many specimens of the summer form *prorsa* revert to it by means of cold, whereas the converse change could not be effected; and (*b*) that the species originally existed in the glacial period as a single-brooded and monomorphic butterfly, and only became double-brooded and gradually developed the *prorsa* form as warmth of climate increased.

With *Pieris napi*, Weismann found the pupæ from eggs laid by the winter form much more responsive to the action of cold (applied immediately after pupation and continued for three months) than those of *A. levana*, by far the larger number emerging as the pure winter form when transferred to a hot-house, and the remainder (which resisted forcing and hibernated) all producing the same form in the following spring. The converse experiment was not tried with the pupæ of ordinary *P. napi*, but with those of the Alpine and Polar variety, *bryoniae*, but the result was in accordance with that of the corresponding experiment in the case of *A. levana*—the application of heat had no transforming effect, and all the butterflies emerged as pure *bryoniae*. Weismann was thus led to regard the single-brooded variety *bryoniae* as the original form of the species from the glacial period, and *napi* in its winter and summer forms as gradually produced under increasing climatic warmth.

The experiments conducted with so much skill and perseverance by W. H. Edwards with the North-American *Papilio ajax* and *Phyciodes tharos* yielded much the same results as those obtained by Weismann in Europe. In the complicated case of *P. ajax*—where the winter form presents itself in the two differing generations known as *walshii* and *telamonides*, and the summer form known as *marcellus* appears in three similar generations—Mr. Edwards, by the application of ice for a period of two months, found that fifty pupæ reared from eggs laid by the second generation of the winter form (*telamonides*), which under natural conditions would nearly all have given the summer form *marcellus*, produced no fewer than twenty-two *telamonides*, one specimen intermediate between *telamonides* and *walshii*, eight examples intermediate between *telamonides* and *marcellus*, but nearer to the former, eight intermediate between the same forms but nearer to the latter, and only eleven true *marcellus*. It should be observed, however, that there is a difference in the shape of the wings between the winter and summer forms of this *Papilio*, and that the strong innate tendency of the progeny of the winter form to assume the summer form was evidenced in the fact that all the butterflies from the refrigerated pupæ which had the markings of *telamonides* or of *walshii* yet bore the shape of *marcellus*.

The extreme variability of *Phyciodes tharos* renders it difficult to follow the details of Edwards' experiments with the various broods from different districts, but it is clear that, as in the case of *P. ajax*, the application of cold induced the summer form to revert to the winter form (*marcia*). I do not gather that the converse experiment was tried with this butterfly; but it was attempted to a certain extent with *Papilio ajax*, whose hibernating pupæ were subjected to a moderate degree of heat during some months, for several years in succession, without any change being effected in the resulting winter form of the butterfly. The evidence in the case of *Grapta interrogationis* has a different bearing on the subject, seeing that this species does not hibernate as pupa but as imago, and that therefore there is not, strictly speaking, any "winter" form; but it would appear that the first of the four broods in the year consists wholly of the form named *umbrosa* and the fourth of the form named *fabricii*, while the intervening second and third broods are each composed of both forms.

Only brief reference is made by Weismann to the experiments on *Araschnia levana* made by G. Dorfmeister,[1] an account of which was published as far back as 1864, but a full *résumé* of them has been given by the late Prof. Th. Eimer.[2] From this I find that, although, as Weismann points out, Dorfmeister did not succeed—apparently from not employing a low enough temperature—in transforming the *prorsa*-form into the *levana*-form, but obtained only some few of the intermediate form *porima*, yet he was apparently repeatedly successful in the important converse experiment (where Weismann's results were almost negative), obtaining *prorsa* by means of warmth from the *prorsa* August brood. He further obtained numerous gradations of the intermediate form *porima*, stages which under natural conditions occcur so rarely that, during forty years' collecting, he met with only a single specimen in the wild state in places where the forms *levana* and *prorsa* were quite common. Dorfmeister was clearly the first to point out that temperature exercises its chief influence during the act of pupation or shortly afterwards, but he expressed his "inability to decide whether the modifications obtained were the direct consequence of the rise in temperature, or only the indirect, depending on the shortening of the time of development caused by the increased temperature."

Familiar to all of us is the fine series of papers on temperature experiments contributed to our *Transactions* and *Proceedings*, to the *Entomologist*, and to the *Proceedings* of the South London Entomological Society by our Secretary, Mr. F. Merrifield; they are eight in number, the first having been published in 1888 and the last in 1897.[3] Mr. Merrifield's earlier experiments were made with Geometrid moths of the genera *Selenia* and *Ennomos*, certain species of which have normally two differing seasonal forms in England, and they extended to the application of both icing and forcing for various periods in all stages from egg to imago. The results were of much interest from many points of view, and more especially as showing (*a*) that the continued application of low temperature to the pupæ reared from eggs laid by the spring brood produced moths more and more like their parents, instead of the natural summer form; (*b*) that the opposite experiment of applying heat to the pupæ from eggs of the summer brood was fatal to a majority of individuals, and produced in the survivors a proportion of the summer form but mainly specimens intermediate only between the spring and summer types; (*c*) that it was in the pupal state that temperatures exercised their chief influence; (*d*) that forcing produced pale and comparatively spotless moths, while cooling or icing produced dark and much spotted ones. Another noteworthy point was that the application of *moisture* in combination with various temperatures to the pupæ of *S. tetralunaria* and *E. autumnaria* had no effect on the resulting moths.

The dimorphic species next treated by Mr. Merrifield in 1892–93 were *Pieris napi*, *Araschnia levana*, and *Chrysophanus phlaeas*. The results in the first and second of these species were generally confirmatory of those obtained by previous experimenters. In the case of *C. phlaeas*, which, though many-brooded almost throughout its immense range, does not exhibit seasonal dimorphism in Europe except in Southern Italy, Corsica and Greece, forcing caused on the upper side the dusky suffusion and larger black spots of the forewings characteristic of the southern summer form *eleus*, while cold induced exactly the opposite characters in the forewings, and also a great broadening and radiation of the coppery band in the hindwings. In 1896, Mr. Merrifield experimented on pupæ of *Pieris daplidice*, and found that forcing produced the ordinary summer form, while cooling for six weeks brought out the spring form *bellidice*.

I have here only very briefly mentioned those of Mr. Merrifield's experiments which dealt with seasonally-dimorphic species. His researches extended besides to upwards of twenty monomorphic ones; they were carried out with admirable skill, care, and exactness of record, and the resulting phenomena—especially in the species of *Vanessa*—were not only most

[1] "Ueber der Einwirkung verschiedener während der Entwickelungsperioden angewendeter Wärmegrade auf das Farbung und Zeichnung der Schmetterlinge." (*Mittheil. Naturw. Vereins für Steiermark*, 1864.)

[2] "Entstehung der Arten auf Grund von Vererben erworbene Eigenschaften nach der Gesetzen organischer Wächsens," 1888. (Engl. transl., by J. T. Cunningham, 1890, Sect. iv. pp. 131–134. I have to thank Mr. Merrifield for lending me this work.)

[3] For a most convenient *précis* and illustration of Mr. Merrifield's work, by Dr. F. A. Dixey, see NATURE, vol. lvii. pp. 184–188 (1897)

remarkable in themselves, but also, as disclosing apparently ancestral characters, of the deepest interest in their bearing on the phylogeny of the species concerned. The latter aspect of these investigations has been ably dealt with by Dr. F. A. Dixey, who, in his published comments on Mr. Merrifield's papers of 1893 and 1894,[1] points out that they seem to go far towards indicating the possibility that a disturbance of natural temperature conditions, whether in the direction of heat or cold, can produce in a monomorphic species a tendency towards reversion, and also notes the production by these experiments of ancestral features in *Vanessa io*, *V. polychloros*, and *Grapta C.-album*.

Concurrently with Mr. Merrifield's later work appeared both Dr. M. Standfuss's[2] and Prof. Weismann's[3] important memoirs, containing accounts of the series of temperature experiments carried on by them respectively in the course of the last decade. Standfuss's paper of 1894 deals with the effects of the warm and cold treatment of the summer pupæ of nine species of European butterflies. None of these can be included among seasonally-dimorphic species in Europe itself, but the author points out that the effect of heat on the Zürich pupæ of *Papilio machaon* was to produce specimens perfectly resembling the August form of the species that is found in Syria. Other striking results as given by the experimenter were the production of specimens representing (*a*) Local forms, such as constantly occur in nature in certain definite localities; in *Vanessa urticae*, *Pyrameis cardui*, and to some extent in *Papilio machaon* and *Vanessa antiopa*: (*b*) Aberrations, like those which now occur in nature; in *V. io*, *P. cardui*, and *Argynnis aglaia*: (*c*) Phylogenetic forms, "which may have either existed in past epochs, or may perhaps be destined to arise in future": in certain cooled *V. io* and *V. antiopa* and certain warmed *V. atalanta*, and the reverse respectively. Noting the remarkable circumstance that the same conditions lead to such diverse effects in different species—the changes wrought in one species being entirely within the limits of its variation at the present day, while in another they far surpass those limits—he suggests that the species coming under the former category are the phylogenetically older, and those belonging to the latter are the phylogenetically younger. The author found that the high temperature of 104° F. rapidly caused death in nearly all the species tested—*P. machaon* and *G. C.-album* proving least sensitive—but low temperatures prolonged for even four weeks are much better tolerated; and it was thought that this favoured the conclusion that the species so tested "were constrained in past ages to accommodate themselves much more to lower than to higher temperatures."

In the edition of his "Handbuch," which appeared in 1896, Standfuss recapitulated the cases published in 1894, and added mention of a warmth experiment with *Gonepteryx rhamni* which had the effect of inducing in the females some indications of the yellow colouring of the males. He also gave excellent coloured figures of most of the more marked variations resulting from temperature treatment, some of them exhibiting marvellous divergence from the normal form now existing in nature.

Before turning to Weismann's memoir of 1895, it will be convenient to refer briefly to Standfuss's recent and elaborate treatise issued during 1898.[1] After reviewing (in Sect. I.) his experiments as to effects from treatment of pupæ with constant moderately high (+37° to +39° C.) or moderately low (+4° to +6° C.) temperatures in the years from 1885 to the beginning of 1895, the author proceeds (in Sect. II.) to give an account of the continuation of these "Warm and Cold" experiments during the succeeding period from the middle of 1895 to 1897. These additional experiments were made on no fewer than fifty-six species of European Lepidoptera (thirty-six butterflies and twenty moths), and on a largely-increased number of specimens; and their results were found to be fully confirmatory of those derived from the earlier more restricted experiments, affording various fresh instances of the production of more or less marked variation in the directions previously indicated, viz. seasonal forms, local forms, aberrations, phylogenetic forms, and forms showing assumption of the male colouring by the female. Under the respective headings of "Frost-Experiments" (Sect. III.) and "Heat-Experiments" (Sect. IV.), the several results are given of employing temperatures under 0° C. (0° to −18° C., and exceptionally to −20° C.), and those above +40° C. (up to +45° C.); and the attempt is made (Sect. V.) to explain from the results of these two sets of experiments the active cause of most of the "Aberrations" occurring in nature. Attention is directed to the extremely interesting fact that the aberrations resulting from the artificial very high temperatures agree closely with the aberrations found in nature,[1] while aberrations like those produced by the use of very low temperatures are never found in nature: and the inference drawn from this is that the typical aberrations occurring naturally among the Nymphlidæ are produced by the temporary influence on a high degree of heat (40° to 45° C.).

I cannot here do more than just refer to the remaining sections of Dr. Standfuss's treatise; they include a consideration of the mode of action of the frost and heat experiments, a discussion as to the nature of aberrations, and an account of the further breeding of aberrational *Vanessa urticae*, and with the concluding remarks at pp. 37 and 38 will well repay perusal. Some idea of the satisfactory and extensive scale upon which the experiments were conducted, may be gathered from Standfuss's statement that he had employed altogether during 1895-97 the number of over 42,000 pupæ belonging to about sixty different species.[2]

Weismann's memoir of 1895, above referred to, contains a full record of his later experiments and results in the cases of *Araschnia levana*, *Chrysophanus phlaeas*, and *Pieris napi*, as well as in those of *Pararge egeria* (with its "climatic variety," *meione*) and *Vanessa urticae*. It further treats of the effect on pupæ of variously-coloured light, and on hibernating pupæ of warmth, and concludes with a comprehensive general review of the whole subject, including a comparison of the results of some of his own experiments with those obtained by Merrifield and Standfuss. In the case of *A. levana*, he not only succeeded, by means of temperatures of 27-28° C. and 30-32° C., in obtaining repeatedly a small number of the *prorsa*-form from the second summer generation of that form, but also proved that occasionally the same result arose in isolated instances without the use of a higher temperature than that of an ordinary warm room. It was further established that the intermediate forms known as *porima*, so rare under natural conditions, are produced whenever a brood is subjected to an unsuitable temperature at the beginning of the pupal stage, occurring indeed with the second brood from unusual cold, and with the third brood from unusual heat. As regards the seasonal forms of *Pieris napi*, it was shown that the low temperature effects the conversion of the summer form into the winter, only when specially applied immediately after pupation; while repeated experiments with the variety *bryoniae* gave no sufficient support to Weismann's view that this variety was the original parent-form of *napi*.

It is in this memoir that Weismann first recognises fully what he had formerly questioned, but had latterly ("Aeussere Einflüsse als Entwickelungsreize," 1894), put forward as probable, viz. that, besides the direct seasonal dimorphism attributable to temperature, there also exists *adaptive* seasonal dimorphism dependent on the indirect influence of the varying environment according to the time of year. He again cites the case of *A. levana* itself as possibly exhibiting in its *prorsa*-form mimicry of *Limenitis*, and suggests that the seasonal forms of *P. napi* may be adapted on the underside to the vegetation tints of spring and summer respectively. In the case of the latter species he expresses the belief that adaptive and direct seasonal dimorphism are combined, pointing out that the differences presented by the upperside may perhaps be referred to the direct influence of temperature. The possible adaptation

[1] See Dr. Dixey's papers (1) "On the Phylogenetic Significance of the Variations produced by difference of Temperature in *Vanessa atalanta*" (*Trans. Ent. Soc. Lond.*, 1894, p. 69); and (2) "Mr. Merrifield's Experiments in Temperature Variation as bearing on Theories of Heredity." (*Op. cit.* 1894, p. 439.)

[2] "Ueber die Gründe der Variation und Aberration des Falterstadiums bei den Schmetterlingen," 1894 (Engl. transl. by Dr. F. A. Dixey in *Entomologist*, 1895.) "Handbuch der Paläarktischen Gross-Schmetterlinge für Forscher und Sammler," 1896.

[3] "New Experiments on the Seasonal Dimorphism of Lepidoptera" (1895). Engl. transl. by W. E. Nicholson in *Entomologist*, 1896.

[4] "Experimentelle Zoologische Studien mit Lepidopteren. A. Temperatur-Experimente." (*Denkschr. Schweiz. Naturf.-Gesellsch.*, xxxvi. i. 1898.)

[1] This is well illustrated by Plate IV. accompanying the memoir, where figures of Aberrations, (*a*) captured at large, and (*b*) forced at very high temperature, of the following species, are given side by side, viz. *Vanessa polychloros*, *V. antiopa*, *V. atalanta*, and *Pyrameis cardui*, Figs. 1, 3, 5, 7 differing very slightly respectively from Figs. 2, 4, 6, and 8. (Plate III. figures the Aberrations produced in the same four species by "Frost-Experiments.")

[2] Dr. E. Fischer, of Zurich, has also carried out very extensive temperature experiments on European Lepidoptera with most striking results, which are mentioned by Weismann, Merrifield, and Standfuss. I have not seen Dr. Fischer's published accounts of his work, but I believe he did not experiment with seasonally dimorphic species.

of the green-and-white underside of the dimorphic *Anthocharis belia* to the respective resting plants of each season is also indicated.

The poverty, however, of such instances among the seasonally dimorphic species of the European butterfly-fauna is manifest; and it is thus satisfactory to find Weismann turning, in support of his view, to the numerous striking cases (first brought to his notice in 1894 in a paper by Dr. G. Brandes) of seasonal dimorphism occurring in tropical and subtropical regions, among which were instances where one seasonal form at least assumes a special protective colouring. Hitherto all the cases investigated and experimented on, whether in Europe or North America, had been found referable to the influence of high and low temperatures, and nobody seems to have suspected the occurrence of similar seasonal variation in hot countries; but, as Mr. L. de Nicéville, Mr. W. Doherty, and other observers have pointed out, and as Weismann was apt to recognise, the alternation of wet and dry seasons is as actively inciting an agent in the production of seasonal dimorphism in many parts of the tropics, as that of hot and cold ones is in the temperate latitudes.

I must confess that I shared in the prevalent erroneous opinion that seasonal dimorphism was not to be looked for in countries without summer and winter seasons of greatly differing temperatures; and no doubt this was mainly due to my never having resided for any length of time in a region where the rainy season is the warmer and the dry one the cooler. In the south-west of the Cape Colony, where I was stationed, exactly opposite conditions prevail, and in the rainy winter, scarcely a dozen species of butterflies appear, and none of them presents any marked difference from the dry summer specimens of the same species. I was thus unprepared to attach due value to the suggestion, by my friend, Mr. W. D. Gooch, as early as the year 1877, of the occurrence of differing seasonal forms of butterflies in Natal, or to the opinion to the same effect given by Mr. A. J. Spiller in 1880 (*Entomologist*, vol. xiii. p. 3). I believe this communication of Mr. Spiller's to have been the first published information of the apparent occurrence of seasonal dimorphism in the warmer parts of the world; and the four cases which he specially notices (in the genera *Anthocharis* [= *Teracolus*], *Pieris*, *Mycalesis*, and *Hypanis*) are undoubtedly true ones. Mr. Gooch (*op. cit.*, pp. 226 and 273) published his concurrence in the main with Mr. Spiller's view, but at the same time mentioned that, in the only two attempts he made to test the matter, by rearing *Teracolus omphale* and *Pieris severina*, he found no difference between the winter and summer broods, both belonging to the theoretical winter form with reduced black markings.

It was in 1885 that Mr. L. de Nicéville, the well-known authority on Indian butterflies, published[1] a notice of apparent seasonal dimorphism in several species of Calcutta *Satyrinae* of the genera *Mycalesis*, *Ypthima*, and *Melanitis*—the wet-season form presenting distinct ocellated spots on the underside, and the dry-season form being without those markings. He suggested as a possible explanation, that while the conspicuously marked wet-season form is concealed by the dense vegetation, the dry-season non-ocellated form had in the scantily-clothed jungle found protection by the gradual loss through natural selection of the conspicuous markings. Mr. de Nicéville's specimens illustrating his paper were exhibited at a meeting of this Society in February 1885, but his view did not meet with much acceptance among the members present, nor was any alternative explanation of the phenomenon brought forward. He was able, however, in the following year to adduce proof of the correctness of his theory in a memoir [2] giving details of the rearing of one seasonal form from eggs laid by the other in four of the seven cases named by him in his previous paper, viz. *Ypthima hübneri* and *Y. howra*; *Y. philomela* and *Y. marshallii*; *Mycalesis mineus* and *M. indistans*; *Melanitis leda* and *M. ismene*; these pairs consisting respectively of the ocellated wet-season form and non-ocellated dry-season form of each species concerned.

Just previously to the latter notable record of Mr. de Nicéville, Mr. W. Doherty had contributed to the same Journal [3] his four years' observation of seasonal variation while collecting Indian butterflies. He brings to notice that, speaking generally, there were *four* broods annually in that country, viz. two in the wet season and two in the dry season, and that, while there was no perceptible difference between the two broods of the same season, there were often very marked differences between the wet-season broods and the dry-season ones. These differences included size (the wet-season form being usually smaller), the angulation of the wings, and the colouring and ocelli of the underside, and were well illustrated by species of *Junonia*, *Ypthima*, *Mycalesis*, and *Melanitis*. The author remarks that some countries with wet climate do not yield any but wet-season forms,[1] and conversely that some very dry countries produce only dry-season ones, instancing the case of *Junonia almana*, the dry-season form of which alone occurs in Scinde, while its wet-season form (*asterie*) only is met with in Ceylon and Singapore. He is of opinion that De Nicéville's view is strengthened by the fact that the dry-season forms are more or less leaf-like both in shape and in the underside colouring, while no such resemblance is manifested by the wet-season ones, and argues that this points to the greater exposure to danger in the dry season; but he is inclined to think that the eye-like underside markings in the wet season may serve as a protection from the attacks of birds. It is singular that, while this observant collector enumerates no fewer than twenty-three species of Pierinae in his "List," he does not seem to have noticed the occurrence of seasonal dimorphism in the subfamily which is especially fertile in illustrations of it.

In view of the satisfactory evidence afforded by De Nicéville's experiments with Indian Satyrinæ, I could no longer doubt that many hitherto puzzling cases of variation among African butterflies would find their solution in the same way, especially as the dated specimens accessible all pointed to the seasonal character of the varieties. I kept the question constantly before my entomological correspondents in Natal and the other warmer parts of South Africa, and was enabled by their assistance to indicate in 1889 ("South-African Butterflies," iii. pp. 6, 7, 125, and 395, 1889), various extremely probable instances of a corresponding phenomenon among African Satyrinæ and Pierinæ. Among a most interesting collection made by Mr. A. W. Eriksson in tropical South-west Africa, described by me in 1891 (*Proc. Zool. Soc. Lond.*, 1891, pp. 59, 64, 85, 89, 96, 97, and 99), I noted what appeared to be undoubted cases of seasonal dimorphism in species of Acræinæ, Lycænidæ and Pierinæ; and again, in cataloguing Mr. F. C. Selous's Manica butterflies in 1894 (*op. cit.*, 1894, pp. 14, 22, 29, 37, 64, and 67), I showed reason for recognising the prevalence of the same kind of variation, especially pointing out how in the case of *Melanitis leda* all the dated South African examples went to confirm De Nicéville's experience at Calcutta, and what strong similar ground existed for considering the much-discussed variation in the Nymphaline *Hamanumida daedalus* to be seasonal.

An important contribution to the elucidation of the subject was made in 1894 by the late Captain E. Y. Watson in a paper entitled "Notes on the Synonymy of some Species of Indian Pierinæ" (*Journ. Bombay Nat. Hist. Soc.*, viii. p. 489 (1894).

According to this experienced entomologist's observations some species—*Terias hecabe*, for instance—produce successive broods (from four in the cooler to ten or twelve in the warmer districts) throughout the year, and the last alone of the wet-season or dry-season broods respectively yields offspring exhibiting the opposite seasonal form; but it is at the same time pointed out that "in some cases the eggs laid by one female would produce more than one form, according to the state of the atmosphere shortly before the emergence of each individual, which is the period at which it would be chiefly affected." The author calls attention to the fact that "in different parts of the Indian Region, the seasons vary to a certain extent, so that it cannot be laid down that specimens captured in any particular month will belong to any particular form"; he defines, however, roughly the limits of the rainy and dry seasons and states that "the very large majority of specimens obtained during those periods will be wet- and dry-season forms respectively." Emphasis is laid on another important point, viz. that the

[1] "List of the Butterflies of Calcutta, &c." (*Journ. Asiat. Soc. Bengal*, liv. pl. ii. p. 39.)

[2] "On the Life-History of certain Calcutta Species of Satyrinae, with special reference to the Seasonal Dimorphism alleged to occur in them." (*Op. cit.*, lv. pl. ii. p. 229, 1886.)

[3] "A List of Butterflies taken in Kumaon." (*Journ. Asiat. Soc. Bengal*, lv., pt. ii. p. 107.)

[1] Mr. de Nicéville has recorded (*Journ. Asiat. Soc. Bengal*, lxiv., pt. ii. p. 362, 1895) that in N.E. Sumatra rain falls in every month of the year, and it is rare for a week to pass without a shower, and that consequently there are no dry-season forms of butterflies to be found there, with the solitary exception of the dry-season form of *Melanitis leda*, which (as in Java) prevails all the year round as commonly as the wet-season form.

seasonally dimorphic species present numerous intermediate forms, and that these intermediate forms themselves vary according to the vegetation and rainfall, "so that the extreme of a rainy-season form from a district where the rainfall is great and the vegetation dense, is much more pronounced than the extreme of a rainy-season form from a district with slight rainfall and sparse vegetation; and these differences are even more marked in the dry-season forms." The genera of *Pierinae* dealt with in this paper are *Huphina*, *Appias*, *Ixias*, *Terias*, and *Teracolus*, and seasonal dimorphism is shown to prevail largely in all of them, so that the author feels warranted in materially reducing the number of hitherto admitted species, contending that many of these are palpably founded on mere seasonal variations.

In 1895, I had the pleasure of receiving from a valued friend and correspondent in Natal, Mr. Cecil N. Barker, the MS. of an interesting paper he had drawn up, from many years' field observations, on the seasonal variation of butterflies in that colony and the adjacent territories. This paper, which was published the same year,[1] proceeds on much the same lines as that of Captain Watson's just noticed, but, instead of being confined to the Pierinæ, traces the occurrence of the phenomenon throughout the suborder, indicating the following cases, viz. Acræinæ 1 (in *Acraea*); Satyrinæ 2 (in *Mycalesis*); Nymphalinæ 9 (1 each in *Atella*, *Junonia*, *Hypanis*, *Hamanumida* and *Charaxes*, and 2 each in *Precis* and *Crenis*); Lycænidæ 3 (in *Lycaena*); and Pierinæ 20 (9 in *Teracolus*, 4 in *Pieris*, 3 each in *Eronia* and *Terias*, and 1 in *Herpaenia*). In many of these thirty-six cases the seasonal differences and the occurrence of intermediate specimens about the change of season are carefully described; and several instances are recorded of the pairing of *Pieris gidica* with *P. abyssinica* or with intermediate examples. Mr. Barker's observations were decidedly in support of my own published opinion as to the seasonal dimorphism of *Hamanumida daedalus*, *Herpaenia eriphia*, *Teracolus regina*, *T. speciosus*, *Pieris pigea*, *P. gidica*, *Eronia cleodora*, and *E. leda*.

Mr. Barker's paper was soon followed by one of equal interest[2] contributed to our *Transactions* by Mr. G. A. K. Marshall, who has a most wide and intimate knowledge of butterfly-life south of the Zambesi. Mr. Marshall, after expressing his concurrence with Mr. Barker's opinions on the subject, proceeds to criticise with justice Dr. A. G. Butler's rather random suggestion (*Trans. Ent. Soc. Lond.* 1895, p. 519) that in the Acræinæ the presence of a broad apical black patch on the forewings indicates a wet-season form, proving this idea to be wholly untenable, at any rate in three of the five cases advanced by Dr. Butler. He goes on to indicate the signs of seasonal variation in nine species of *Acraea*, and notably in the Mashunaland *A. halali*, where both sexes vary strongly, and unlike the other known cases in the genus, have the black spots larger in the dry-season than in the wet-season form. To the numerous instances given by Barker he adds two more in *Mycalesis* and eight more in *Precis*. The latter are shown to offer a beautiful series of gradations in dimorphism, from the four species *P. natalica*, *P. elgiva*, *P. tugela* and *P. artaxia*, where—in addition to larger size and more falcate forewings—the dry-season change is almost limited to the dull withered-leaf colour and marking of the underside; then to the two species *P. ceryne* and *P. archesia*, where the upperside as well presents considerable alteration both in colour and marking; and finally, to the species *P. simia* and *P. octavia-natalensis*, where the suggested respective dry-season forms *P. cuama* and *P. sesamus* present such extreme disparity in the aspect of both upper and under sides as to render it almost incredible that they can belong to the same species as the two wet-season forms in question.

The actual rearing of the dry-season form of *Terias zoe* from eggs laid by the latter, and its proving to be (as had long been anticipated) the butterfly known as *T. brigitta*, is recorded in this paper on the authority of that practised collector and observer, my friend Mr. J. M. Hutchinson, of Estcourt in Natal; and early in 1897, Mr. Marshall, writing from that locality, informed me that he had succeeded in rearing three specimens of *Teracolus auxo*, a wet-season form, from eggs laid by *T. topha*, a dry-season butterfly. In each of these two Pierine cases the close relationship of the seasonal forms was so manifest, that all the circumstances of their occurrence led one to expect the species-identity to be proved before very long; but it was otherwise in the case of *Precis octavia-natalensis* and *P. sesamus*, notwithstanding the significant facts—very close resemblance in both larvæ and pupæ, occasional pairing of the two forms, and the existence of various intermediate examples—which favoured a similar conclusion. Thus it was with no ordinary interest that I received from Prof. Poulton Mr. Marshall's announcement, in a letter dated June 1898, that in three cases he had bred *P. sesamus* from the eggs laid by *P. octavia-natalensis*, and that I saw the actual specimens of parent and offspring in two of the three cases, which had been sent to the Hope Department of the Oxford University Museum. An excellent account by Mr. Marshall of what he rightly describes as "the most remarkable instance of seasonal variation as yet known" was published in July last.[1] What makes the case so striking is not alone the very great difference of the upperside—deep salmon-red with black borders and spots in *octavia-natalensis*, and violaceous-blue streaked with black, and a continuous series of salmon-red spots in *sesamus*—but that of the underside also—almost the same as the upperside, but pinker in *octavia-natalensis*, and very dark greenish-bronze with black streaks in *sesamus*. Owing to the latter disparity nothing could be more different than the appearance of the two forms when at rest, *octavia-natalensis* being very conspicuous, while *sesamus* is well concealed;[2] and this wide divergence is associated with the differing haunts and habits of the two forms. Mr. Marshall seems inclined to the view that the wet-season form *octavia-natalensis* is the older one, and that the dry-season form *sesamus*, with its distinctly protective underside, may be the result of greater persecution—in the scarcity of insects of other orders—during that season. On the other hand, he suggests the possibility of the wet-season *natalensis*-form being in process of modification in mimicry of the prevalent red black-spotted *Acraeae* of the same region, in which case *sesamus* would have to be taken as the older form. I consider the latter to be more likely than the former view, seeing how much less *sesamus* has diverged than *octavia-natalensis* from the general pattern of the genus *Precis*.[3]

A noteworthy fact in Mr. Marshall's experience in this case was that, while in the second instance recorded he reared an example of *sesamus* from an egg laid by *octavia-natalensis*, he also obtained, only five days later, from another egg laid by the same mother, on the same day, a pure *octavia-natalensis*. He expressly states that the two larvæ from which these amazingly different butterflies resulted were reared from the egg under precisely similar conditions; and he adds that not a few similar instances had come under his notice. This is sufficiently remarkable, but it by no means exhibits the apparent extreme of variation among the offspring of one mother; for Mr. de Nicéville (in a letter of June 13 last) assures me that in India "at the change of the season, in one brood, from one batch of eggs laid by one female, you sometimes get both seasonal forms and all intermediate ones."[4] Such cases, like those of more or less complete resistance to altered temperature, so frequent in the experiments of Weismann and others, point very clearly to the operation of some other factor than the degree of humidity, or of temperature; but it must be admitted that we are as yet quite in obscurity as to its actual nature, and that our investigations into seasonal dimorphism must be far more systematically and thoroughly prosecuted before conclusions of a satisfactory character can be arrived at.

While the observations already on record, to which I have drawn attention above, render it beyond question that seasonal dimorphism is of world-wide prevalence, it is at the same time surprising—considering the great and increasing study devoted to exotic butterflies of late years—that so very little is definitely known of the actual range and conditions of its occurrence beyond European limits. So far as the Palæarctic Region is

[1] "Notes on Seasonal Dimorphism of Rhopalocera in Natal. (*Trans Ent. Soc. Lond.*, 1895, p. 413.)

[2] "Notes on Seasonal Dimorphism in South African Butterflies." (*Op. cit.*, 1896, p. 551.)

[1] See "Seasonal Dimorphism in Butterflies of the Genus *Precis*, Doubl." (*Ann. and Mag. Nat. Hist.* (7). ii. p. 30 (1898).

[2] The rarely-occurring intermediate examples, as I have pointed out ("South Afr. Butt.," i. pp. 230, 231, and 233, 1887), exhibit a complete gradation as respects both upperside and underside.

[3] The only other species of *Precis* of the *octavia* pattern and colouring is *P. simia* (considered by Mr. Marshall to be the wet-season form of the dry-season *P. cuama*), and this species may possibly also be mimetic of the *Acraeae*.

[4] It would be of the very greatest service to these inquiries if such a series as this, the offspring of one mother, could be preserved in its entirety, together with a full record of all the conditions bearing on the case. Mr. de Nicéville does not mention the actual species to which his remark applies.

concerned we are indebted to Standfuss[1] for a comprehensive list of the cases recognised, distinguishing between those where the seasonal disparity is so marked as to have led to the bestowal of distinct names on the two forms, and those where the disparity is less and no second name has been given. In the former category there are 23 cases (17 in Butterflies and 6 in Moths), and in the latter 15 (14 in Butterflies and 1 in Moths), making in all 38 cases, viz. 31 in Butterflies and 7 in Moths. The butterflies comprised in the more marked category include 1 case in Satyrinæ, 2 cases in Nymphalinæ, 5 in Lycænidæ, 6 in Pierinæ, and 3 in Papilioninæ; while those in the less marked category are three cases in Satyrinæ, 3 in Nymphalinæ, 3 in Lycænidæ, and 5 in Pierinæ, so that taking the totals of both categories in their order of numerical importance we have 11 cases in Pierinæ, 8 in Lycænidæ, 5 in Nymphalinæ, 4 in Satyrinæ, and 3 in Papilioninæ. The moths are ranked in the more marked category with the exception of a Liparid (*Dasychira abietis*); they are two in the Bombycidæ and four Geometers. The number of known cases in the Palæarctic Region thus appears to be very small, when contrasted with the very large number of species of the groups to which they belong ascertained to inhabit the region; but it may be observed that a considerable proportion of them must be of greatly extended occurrence and very ancient standing, Pryer[2] noting no fewer than six of them in Japan (besides three additional cases in local species); and Dr. A. Fritze[3] further recording in the same country the case of *Araschnia levana* (var. *burejana*).

When we turn to the great tropical and subtropical regions, where butterfly life finds its fullest and most varied development, it is almost disheartening to find how extremely little has been done in the observation of this apparently prominent feature of seasonal variation. With the exception of India in the Oriental Region, and South Africa in the Ethiopian Region, none of the hot or warmer countries have hitherto received the slightest investigation as regards this particular subject of biological inquiry. I can find no record of any observations in East or West Africa, in Australia, or in Central and South America. Feeling especially the deplorable lack of information from that paradise of butterflies, the Neotropical Region, I consulted Dr. F. A. Dixey with the view of ascertaining whether the Pierinæ—the group which he has made so emphatically his own, and which in the Old World has yielded more cases of seasonal dimorphism than any other—offered any instances of the kind in Central or South America. He most obligingly brought together, in the Hope Department of the Oxford University Museum, a series of Neotropical species of *Callidryas*, all of which included forms corresponding in character with the seasonal varieties occurring among their Old-World congeners and allies, viz. a larger form, of deep or rich colouring with the underside freckling and markings strongly expressed; a smaller form, of paler colouring, with the underside freckling and markings very faint or altogether absent; and, in addition to these, specimens holding an intermediate position between them as regards the characters mentioned. Dr. Dixey exhibited this series (with some additions and substitutions) at the Society's meeting on December 7, and explained that, in order to meet the possible objection that the variations in question pointed to *local* forms, he had been careful in the case of each species to select examples from the same locality. The species concerned were *C. rurina* (Mexico), *C. neocypris* (South Paraguay), *C. argante* (Brazil), *C. agarithe* (Mexico), *C. sennae* (Guatemala and Brazil), and *C. philea* (Guatemala). There was no sufficient evidence as to the seasons of appearance of these variations, only seven examples (four *C. argante* and three *C. sennae*) in the whole series bearing dates of capture; but the nature of them, and the parallelism with which they were displayed by each of the six species, were such as to leave little doubt of their being seasonal.

I am further indebted to Dr. Dixey for the first indication of the occurrence of seasonal dimorphism in Australia, afforded by the Old-World section (*Catopsilia*) of the same genus *Callidryas*. In one species, *C. gorgophone*, from Melville Island and Queensland, gradations are found quite in correspondence with those observed in both Indian and Neotropical species; and the same phases are even more completely illustrated in a fine series of Brisbane examples of the well-known Oriental *C. crocale*, which lends some probability to Dr. Dixey's suspicion that *C. crocale* and *C. pomona* (including *C. catilla*) will prove to be seasonal forms of one species.[1]

In bringing to a close this attempt to give a general survey of what has been published on the subject, I purposely abstain from indulging in any speculative disquisition on my own part, because, however attractive to myself such a course might be, I very much doubt if, in the present very restricted bounds of our knowledge, it would prove of any service to the Society. To generalise or to speculate to any good purpose demands a considerable body of well-ascertained fact as a basis, and this—as my remarks have shown—is precisely what is wanting in the present instance, notwithstanding the labours of the entomologists of distinction to whom reference has been made. While fully recognising that the artificial-temperature experiments noted above have been designed and conducted with a skill and thoroughness truly admirable so far as certain species of Palæarctic and Nearctic Lepidoptera are concerned, it cannot at the same time be denied that even in Europe very little has been done to ascertain all the natural conditions under which seasonal dimorphism occurs, or to what extent it is adaptive to the environment; and when we turn to the wide tropical and subtropical regions, it is obvious that we stand upon merely the threshold of inquiry. We have, indeed, from these regions—thanks to such capable observers as De Nicéville and Marshall—some valid experimental evidence to guide us, but this must be very greatly added to, and the life-history of the dimorphic species be worked out from many different directions, before we can hope to approach to a clear comprehension of the complex problem now presented by the extraordinarily impressionable and mutable lepidopterous organism. In studying the cases under notice, it is impossible not to recognise that the most diverse influences are at work—indications of protective and mimetic adaptation, and of sexual selection as well, being combined or contrasted with the effects of varying temperatures and degrees of atmospheric humidity, and with distinct tendencies in the direction of reversion to ancestral characters.

The investigation is one to tax the insight and resource of the ablest and most zealous naturalists, and demands unremitting and most exact observation and record, with carefully controlled breeding from the ova for many successive generations, during a considerable series of years. I am as fully persuaded now as I was on the occasion of my last year's address, that such researches as these can never be satisfactorily prosecuted, and still less brought to any interpretation of permanent scientific value, without the establishment in tropical countries of fitly equipped biological stations for the special observation and study, under as natural conditions as possible, of the surrounding terrestrial fauna. It is unnecessary to dwell upon the manifest advantages attendant on well-directed work pursued steadily and continuously in such a zoological observatory, planted in the very midst of the abounding forms of tropical life, or to do more than mention the exceptionally favourable opportunities for discovery that would thus be afforded. In conclusion, therefore, I will simply express my firm conviction that from a few well-organised stations of this kind, on carefully chosen sites in the four great tropical regions, science would gain more in ten years than from the casual and incomplete observations of ordinary collectors and travellers for the next half-century.

[1] "Handbuch der Paläarktischen Gross-Schmetterlinge für Forscher und Sammler," ed. 1896, p. 229.

[2] "Rhopalocera Nihonica: a Description of the Butterflies of Japan," 1886–88. The species named are *Papilio machaon*, *P. xuthus*, *Picris napi*, *Colias hyale*, *Vanessa C.-album*, and *Polyommatus phlaeas*.

[3] *Zool. Anzeiger*, 1890, p. 12. Transl. in *Ann. and Mag. Nat. Hist.* 6), v. p. 200 (1890).

[1] *C. crocale* is an extremely variable and very widely distributed butterfly. Mr. de Nicéville (*Gazetteer of Sikkim*, 1894, p. 166; and *Journ. Asiat. Soc. Bengal*, lxiv. ii. p. 490, 1895) considers that *C. catilla* cannot be held a distinct species from *C. crocale*, all the supposed distinctive characters proving quite inconstant, and breaking down when large numbers of specimens are compared. But he does not think seasonal dimorphism comes into play here, "the innumerable varieties which are found in both sexes occurring at all times."

THE PROGRESS OF TECHNICAL EDUCATION.

THE eleventh annual report of the National Association for the Promotion of Technical and Secondary Education is filled with details concerning the systemisation and extension of educational work during last year. A few extracts from the report will show that satisfactory progress was made.

ENGLAND.

It is pleasing to be able to record that, in the year 1897–8, the total amount of money available under the Local Taxation (Customs and Excise) Act, 1890, for technical education and distributed to the local authorities, was again larger than in any precious year, and that a further advance has been made as regards its utilisation for educational purposes.

Of the 49 County Councils in England, 38 are now giving all and 11 are giving part of their grants to educational purposes, while of the 61 County Borough Councils, 56 are devoting all and 5 are devoting part of the fund in a like manner.

In considering the amount of money devoted one way and another, it may be stated that, of the total of 827,000*l.* now available in England alone, no less a sum than 752,000*l.* is being spent upon education. It thus appears that the amount allocated to general county purposes is still as high as 75,000*l.* In this connection it is worthy of note that London's share of the fund now reaches 192,000*l.*, of which the County Council have granted to the Technical Education Board, for 1898–9, a sum of 170,000*l.*, a growth of 20,000*l.* as compared with last year's vote. Again, the Middlesex County Council have recently decided to increase their contribution during the year 1898–9 for the purposes of technical education by 5000*l.* If, after adding these two sums to the 752,000*l.* given above, a deduction is made of the 7000*l.* voted for county purposes by the Staffordshire County Council, there will remain allocated to education for the year 1898–9, the large total of 770,000*l.*

NEW TECHNICAL SCHOOLS.

In last year's report it was stated that there were 168 technical schools built, or about to be built, by local authorities in England, and that 142 involved a capital expenditure of 1,718,000*l.* This information may now be supplemented by particulars obtained in response to a special effort made during the year to secure more detailed data: the results of this effort have been published in two separate articles in the last volume of *The Record*. The articles, which are reproduced in the report, deal respectively with the developments in (1) the county boroughs and in (2) the non-county boroughs and urban districts and the administrative county areas, including London, and they show that, excluding London, a capital sum of at least 2,340,651*l.* has been spent upon technical schools in England, and that there are 239 such schools of different types under the control of, or in course of establishment by, local authorities.

Since the publication of the articles it has been decided to erect new technical schools at Barrow, Beverley, Eston and South Bank, Garston, Morecambe, Selly Oak and Walkden; while technical schools have been erected and opened at Lytham and Pokesdown (Bournemouth). The erecting of schools in seven of these towns (excluding Morecambe and Walkden) will involve a total expenditure of 25,200*l.* To this sum should be added (1) an amount of 20,000*l.*, which the Eastbourne Town Council have decided to spend on a combined technical school and free library; (2) a sum of 60,000*l.*, which the Manchester City Council are about to borrow for furnishing and equipping the new municipal technical school; and (3) 18,221*l* expended on the establishment of the Preston Technical School. It will thus be seen that the aggregate sum incurred in the establishment of technical schools in England up to the present time is 2,464,072*l.*

WALES.

The organisation of technical and intermediate education in Wales continues on the same lines as those indicated in last year's report. The bulk of the available funds is devoted to the purposes of intermediate education, and in several counties (*e.g.* Carmarthen, Carnarvon and Merioneth) the whole grant under the Local Taxation (Customs and Excise) Act, 1890, is similarly utilised. The halfpenny rate under the Intermediate Education Act is levied in all the sixteen counties and county boroughs, and at least ten County and County Borough Councils utilise the provisions of the Technical Instruction Acts. The following is a brief summary of the sums annually appropriated for technical and intermediate education in Wales:—

Residue grant under the Local Taxation (Customs and Excise) Act, 1890	£38,000
Raised by rate under the Technical Instruction Acts, 1889 and 1891	25,000
Raised by rate under the Welsh Intermediate Education Act, 1889, with equivalent grant from Her Majesty's Treasury	£35,000
Total	£98,000

The total sum which has hitherto been absorbed in the erection or adaptation of fifty school buildings in Wales is as much as 182,298*l.*, and in a number of cases half the cost of school buildings has been defrayed by local subscriptions.

It is understood that the University of Wales and the three University Colleges are already profiting by the work done in the county schools. A considerable number of the scholars of the county schools have passed the matriculation examination, either wholly or in part, of the University, and many scholars, with the aid of scholarships won at their several schools, have entered the University Colleges with a view to preparing themselves for a degree. A great deal of technical education is given in evening classes held in connection with some of the county schools, more especially in the mining and the manufacturing districts of Wales.

SCOTLAND.

During the year 1898 the most important matter affecting the organisation of technical and secondary education in Scotland was the passing of an Act whereby a further sum of 35,000*l.* became available on March 31 of this year for the purposes of technical and secondary education.

The Imperial moneys now available for the purposes of higher education in Scotland amount to 181,000*l.*

IRELAND.

In matters relating to technical education the past year was an eventful one in Ireland. In 1897 attention was directed to the question of the introduction of manual and practical instruction in the primary schools by reason of the appointment, by the Lord Lieutenant, of a Commission of Inquiry. Speaking broadly, if the recommendations of this Commission are put into force, the Irish system of science, art, manual and practical instruction will become assimilated to the English; and, having regard to instruction now given in elementary schools in Ireland, this will be a great step in advance.

In 1898 the examination of the system of intermediate education was commenced by another Commission, also appointed by the Lord Lieutenant. The Commissioners have already held several sittings and a large amount of evidence has been received, much of which points to the necessity of giving greater encouragement to the study of science, modern languages and commercial subjects, and to the necessity of inspection and *viva voce* examination, in order to ensure that the schools are properly provided with laboratories, that the instruction in science is not mere book learning, and that modern languages are taught as living and not as dead languages.

Under the Local Government (Ireland) Act, 1898, the new County and County Borough Councils are constituted local authorities within the meaning of the Technical Instruction Acts, and the intimation of the Government of their intention to introduce a measure dealing with technical education in Ireland gives promise of further developments.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. J. ARTHUR THOMSON has been appointed to the chair of Natural History in the University of Aberdeen, vacant by the death of Prof. Alleyne Nicholson.

THE *Athenæum* states that the late W. J. Astrakoff has bequeathed to the University of Moscow a sum of a million roubles, on condition that it shall be expended upon a foundation of a "Moscow University for Women," with three faculties—mathematics, medicine, and natural science. He requires that it shall be placed under the direct administration of the Ministry of Public Education, and the programme correspond exactly with that of the university for men.

THE ninth annual report on the administration of the Goldsmiths' Company's Technical and Recreative Institute at New Cross shows that something should be done to define the work of institutions of this kind, and prevent neighbouring schools from competing with it. The Institute is one of the finest in London; it is well-equipped, and has a competent staff, yet it has to report that the number of class entries for the year ending

September 30, 1898, was 8277, as compared with the 9116 students of the previous year—a decline of 839. A further decline appears probable for the current year. This reduction of numbers is attributed to the extension of the Evening Continuation Schools of the London School Board, in which all fees have now been abolished, and to the establishment by the Board, close to the Institute, of certain special centres, at which many of the subjects already provided for by the Institute are taught gratis. The Governors point out that action of this kind on the part of a body having the control of public funds is open to much question, and, if persisted in, may render voluntary effort, by means of private resources useless, if not impossible. It is to be hoped that the appointment of a single authority to be responsible for technical and secondary education in London will be the means of preventing the unfortunate overlapping and undesirable competition referred to by the Governing Body in their report. The Institute should be given a definite place in the scheme of education in London and nothing should be permitted to interfere with its progress.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, March.—On singular points of linear differential equations with real coefficients, by Prof. M. Böcher (read before the Society, October 29, 1898). Take the equation

$$\frac{d^n y}{dx^n} + \ldots + p_r \frac{d^{n-r} y}{dx^{n-r}} + \ldots + p_n y = 0,$$

where the coefficients (p_r, &c.) are throughout a certain interval $a < x < b$, continuous real (but not necessarily analytic) functions of the real variable x. By a solution the author understands any function of x which together with its first $n-1$ derivatives is single valued and continuous throughout the interval $a < x < b$, and at every point of this interval satisfies the above equation. It is well known that there is one, and only one solution which at an arbitrarily chosen point of the interval in question has together with its $n-1$ derivatives arbitrarily chosen values. The object of the paper is to consider the behaviour of these solutions as we approach one end of the interval. Prof. Böcher confines his attention to the point a. Reference is made to two papers by Kneser ("Crelle," vols. 116, 117). The paper is an extension and generalisation of some of the author's results obtained in a previous paper of this current volume, entitled "The theorems of oscillation of Sturm and Klein."—Some interesting results are given in the Hessian of the cubic surface, by Dr. J. I. Hutchinson (read at the Boston, Mass., meeting, August 1898).—On the simple isomorphisms of a Hamiltonian group to itself, is a notelet read, at the same Boston meeting, by Dr. G. A. Miller. In the paper each *system* of conjugate operators is supposed to contain more than one operator unless the contrary is stated. The results are expressed in three theorems with attendant corollaries. Useful reviews follow:—Œuvres mathématiques d'Evariste Galois (published by the Paris Mathematical Society).—Thése sur la géométrie non-euclidienne, by M. L. Gerard; Lezioni di geometria intrinseca, by E. Cesàro; L'hyperspace à ($n-1$) dimensions; Propriétés metriques de la corrélation générale, by G. Fontené; Théorie der Abel'schen functionen, by Dr. H. Stahl; Differenzrechnung, by A. A. Markoff. All these notices are carefully drawn up, and are replete with bibliographical references. The last work, in its German form, is highly praised, and "no one interested in the calculus of finite differences can afford to be without this valuable treatise" is the reviewer's verdict. Information follows on the usual lines.

THE new number of the *Archives of the Roentgen Ray* contains Major Battersby's paper, read before the Röntgen Society, on the present position of Röntgen rays in military surgery on January 10, illustrated by several fine plates reproduced from photographs and radiographs taken in Egypt during the recent war in the Sudan. There is also a translation of Prof. Röntgen's further observations on the properties of X-rays, being the third communication to the Royal Prussian Academy of Sciences, Berlin, and dated March 10, 1897.

AMONG the articles in the April number of *Natural Science* is one on the development of rivers, and particularly the genesis of the Severn, a translation of Prof. A. Weismann's essay on "Regeneration: Facts and Interpretations."

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, March 20.—Prof. Copeland in the chair.—Sir John Murray read a paper on the temperature over the floor of the ocean, and the maximum and minimum temperature of the surface of the ocean. The results were exhibited in charts, and showed that 92 per cent. of the bottom water of the ocean had a temperature under 40° F. Higher temperatures were met with in areas between the shore and the hundred-fathom line. As regards the surface waters, 87 per cent. of the maximum temperatures, and 75 per cent. of the minimum temperatures, were above 40° F. Sir John Murray pointed out the important bearing the distribution of the temperature had upon nature and amount of the calcareous deposits.—Prof. Cossar Ewart, in a paper on contributions to the theory of heredity (Part ii.), took up the question of intercrossing and variation. The paper might be described as a critical examination of the favourite dictum that intercrossing had a swamping effect, and curbed variation; and, at the same time, an argument in favour of the view that intercrossing had, like cross-fertilisation, a power of inducing variation. No concrete examples could be adduced of intercrossing leading to uniformity. On the other hand, notwithstanding free intercrossing, a new variety of the peppered moth, which recently appeared in England, had gradually displaced over a considerable area the parent form. Prof. Ewart's own experiments on intercrossing among half-wild rabbits favoured the view that intercrossing induced rather than arrested variation. The paper ended with a discussion of the relative value of intercrossing and change of environment as rejuvenators, one conclusion being that, while the constitution might be bettered by a change in the environment, active variation seemed to result from the disturbance that accompanies or flows from intercrossing.—A paper by Dr. T. Muir, on a development of a determinant of the *m n*th order was also communicated.

PARIS.

Academy of Sciences, April 4.—M. van Tieghem in the chair.—Observation of the planet EL (Coggia, March 31) made at the Observatory of Paris with the 38 cm. equatorial, by M. O. Callandreau.—Observations of the planet EL 1899, discovered by M. Coggia at Marseilles, March 31, by M. Stéphan. On the deformation of surfaces of the second degree, by M. G. Darboux.—The calculation by a simple hypothesis of the lateral displacement which should be given to a rider on a bicycle in motion, to carry the centre of gravity of the system to any given small horizontal distance from the base of the machine, by M. J. Boussinesq.—On the synthesis of alcohol, by M. Berthelot. The author shows that although Hennell probably prepared potassium ethyl sulphate from ethylene, he does not appear to have attempted to have prepared alcohol from this, as is usually stated in the text-books.—On antherozoids and double sexual copulation in the angiosperms, by M. L. Guignard. The observations made by the author upon the fertilisation of *Lilium Martagnon* confirm generally the results of M. Nawaschin, the essential phenomenon consisting of a double sexual copulation in the embryonic sac., one giving rise to the embryo, the other furnishing the albumen necessary to the nutrition of the embryo. The paper is illustrated by nineteen diagrams.—Observation of the Swift comet (1899 a) made at the Observatory of Algiers, by MM. Trépied, Rambaud, and F. Sy.—Observations of the Swift comet (1899 a) made at the Toulouse Observatory with the 23 cm. equatorial, by M. F. Rossard.—On several linear groups isomorphous with the simple group of order 25920, by M. L. E. Dickson.—A rapid method for the determination of the specific heat of liquids, by M. D. Negreano. The method is based upon the comparison of the times required to raise the same volumes of the liquid and of water 1° by means of a wire spiral carrying the same current.—On the use of diffraction fringes in increasing the delicacy of galvanometer readings, by M. Pierre Weiss. The method suggested increases the delicacy of reading a given galvanometer four times.—On the Wehnelt electrolytic contact-breaker, by M. A. Blondel.—On the absorption of the Hertzian waves by non-metallic bodies, by MM. Édouard Branly and Gustave Le Bon. The opacity of non-metallic substances to the Hertzian waves depends upon the thickness and nature of the substance, sand and stone being very transparent, Portland cement much more opaque. Moisture increases the opacity.—On a mode of obtaining electric figures

showing the lines of force of an electric field in air, by M. E. Baudréaux. A non-metallic powder is sprinkled upon an insulated horizontal sheet of glass placed in the electric field; on giving the plate a slight shock, the lines of force immediately appear. Diamidophenol, crystallised in small needles two or three millimetres in length, gives the best results; but, in default of this, sugar powder and many other substances give fair figures.—On the reduction of calcium phosphate by carbon in the electric arc, by M. Albert Renault. The results confirm those given last week by M. Moissan.—Absence of free iodine or gaseous iodide in the atmosphere of Toulouse, by M. F. Garrigou. Five hundred cubic metres of filtered air showed no trace of iodine or any gaseous compound of iodine.—On the acetone oils arising from the dry distillation of crude calcium acetate as a source of the methyl-propyl ketones, by MM. A. and P. Buisine. The mixture of ketones obtained by the dry distillation of crude calcium acetate gives a fraction boiling at 70°, known commercially as acetone oil. Two specimens of this were found to be rich in methyl-propyl ketone and methyl-isopropyl ketone. These ketones are readily separated from the oil by means of alkaline bisulphite, and from each other by repeated fractional distillation.—On solanine, by MM. P. Cazeneuve and P. Breteau.—Ice-breaking steamers in Russia, by M. Venukoff.

GÖTTINGEN.

Royal Society of Sciences.—December 10.—A. Sommerfeld: The numerical solution of transcendental equations by successive approximations.—D. Hilbert: On the theory of quasi-abelian *Zahlkorper*.—E. Ehlers: On Palolo (*Eunice viridis*, Gr.).

January 14.—J. Voigt: On the development of the intestinal mucosa.

DIARY OF SOCIETIES.

THURSDAY, April 13.

Royal Institution, at 3.—The Atmosphere: Prof. J. Dewar, F.R.S.

Mathematical Society, at 8.—Note on the Characteristic Invariants of an Asymmetric Optical System: T. J. Bromwich.—Concerning the Four Known Simple Linear Groups of Order 25920, with an Introduction to the Hyper-Abelian Linear Groups: Dr. L. E. Dickson.—On the Direct Determination of Stress in an Elastic Solid, and on the Stress in a Rotating Lamina: J. H. Michell.—The Theorem of Residuation, Noether's Theorem, and the Riemann-Roch Theorem: Dr. F. S. Macaulay.—On Conformal Division: Lieut.-Colonel Cunningham, R.E.

Institution of Electrical Engineers, at 8.—The Hissing of the Electric Arc: Mrs. Ayrton (Conclusion of Discussion.)—Experiments on Alternate Current Arcs by Aid of Oscillographs: W. Duddell and E. W. Marchant. (Discussion to be opened by the Authors with an Exhibition of Experiments.)

FRIDAY, April 14.

Royal Institution, at 9.—Earth Currents and Electric Traction: Prof A. W. Rücker, Sec. R.S.

Royal Astronomical Society, at 8.—Further Observations of Comet Coddington (c 1898): John Tebbutt.—Photographs of the Radiant of the Leonid Meteors, and Attempts to Photograph the Meteor Stream: Dr. Isaac Roberts, F.R.S.—Measures of Southern Double Stars: J. L. Scott.—On the Smallness of the Errors of Star Photographs due to Optical Distortion of the Object-glass with which the Photograph is taken: Prof. H. H. Turner, F.R.S.—Spectroscopic Determinations of Velocity in the Line of Sight: H. F. Newall.—(1) Micrometer Measures of Double Stars made with the 28-inch Refractor in the Years 1896–98; (2) Observations of Planet Eros from Photographs taken with the 30-inch Reflector of the Thompson Equatorial: Royal Observatory, Greenwich.

Malacological Society, at 8.—Notes on *Paludesirina Jenkinsi*, Smith, and *P. confusa*, Frauenf.: A. S. Kennard and B. B. Woodward.—Descriptions of Two Supposed New Species of *Nassa*: G. B. Sowerby.—On Supposed New Species of *Streptaxis*, *Amphidromus* and *Bulimulus*: H. Fulton.—Remarks on the Genus *Rhodea*, with Descriptions of New Species from South America; also of a New Species of *Papuina* from New Guinea: S. I. DaCosta.

MONDAY, April 17.

Society of Arts, at 8.—Leather Manufacture: Prof. Henry R. Procter.

Victoria Institute, at 4.30.—Sub-oceanic Terraces, Western Europe: Prof. Hull, F.R.S.

TUESDAY, April 18.

Royal Institution, at 3.—Zebras and Zebra Hybrids: Prof. J. C. Ewart, F.R.S.

Zoological Society, at 8.30.—On the Extinct Birds of Patagonia. I. The Skull and Skeleton of *Phororhacos inflatus*, Ameghino: C. W. Andrews.—A Systematic Description of Parasitic Copepoda found on Fishes, with an Enumeration of the known Species: Staff-Surgeon P. W. Bassett-Smith, R.N.—On the Species of *Canidae* found on the Continent of Africa: W. E. de Winton.

Institution of Civil Engineers, at 8.—Buenos Aires Harbour Works: J. M. Dobson.

Royal Statistical Society, at 5.—The Statistical Aspect of the Sugar Question: George Martineau.

Royal Photographic Society, at 8.—Apparatus for Half-tone Process Work.

WEDNESDAY, April 19.

Society of Arts, at 8.—London's Water Supply: Walter Hunter.

Royal Meteorological Society, at 7.30.—Soil Temperature: Henry Mellish.—Some Phenomena connected with the Vertical Circulation of the Atmosphere: Major-General H. Schaw, C.B.

Royal Microscopical Society, at 8.—The Bioplasm of Man and the Higher Animals, and its Influence in Tissue Formation, Action and Metabolism: Prof. Lionel S. Beale, F.R.S.

THURSDAY, April 20.

Royal Society, at 4.30.—The Physiological Action of Choline and Neurine: Dr. Mott, F.R.S., and Dr. Halliburton, F.R.S.—Intestinal Absorption, especially on the Absorption of Serum, Peptone, and Glucose: Prof. R. Waymouth Reid, F.R.S.—Studies on the Morphology of Spore-producing Members. No. 4. The Leptosporangiate: Prof. F. O. Bower, F.R.S.—Note on the Fertility of Different Breeds of Sheep, with Remarks on the Prevalence of Abortion and Barrenness therein: W. Heape.—Some further Remarks on Red-water or Texas Fever: A. Edington.

Royal Institution, at 3.—The Atmosphere: Prof. J. Dewar, F.R.S.

Linnean Society, at 8.—The Botany of the Ceylon Patanas: H. W. H Pearson.—Imitation as a Source of Anomalies: Prof. R. J. Anderson.—List of British and Irish Spiders.—Rev. O. Pickard Cambridge, F.R.S.

Chemical Society, at 8.—Some Dipyridyl Derivatives from Citrazinic Acid: W. J. Sell and H. Jackson.—On the Interaction of Mercurous and Mercuric Nitrites, with the Nitrites of Silver and Sodium: P. C. Ray.—The Synthesis and Preparation of Terebic and Terpenylic Acids: W. Trevor Lawrence.—The Allotropic Modifications of Phosphorus: D. L. Chapman.—β-Isopropyl Glutaric Acid: F. H. Howles and J. F. Thorpe.—Ethyl Ammoniumsulphite: Edward Divers and Masataka Ogawa.—Ethyl Ammonium Selenite and Non-existence of Amidoselenites (Selenosamates): Edward Divers and Seihachi Hada.

Institution of Civil Engineers, at 8.—"James Forrest" Lecture: Magnetism: Prof. J. A. Ewing, F.R.S.

FRIDAY, April 21.

Royal Institution, at 9.—Structure of the Brain in Relation to its Functions: Frederick Walker Mott, F.R.S.

BOOKS AND SERIALS RECEIVED.

Books.—An Introduction to the Carbon Compounds: R. H. Adie (Clive).—A School Arithmetic: R. F. Macdonald (Macmillan).—A System of Medicine: edited by Dr. T. Clifford Allbutt, Vol. vi. (Macmillan).—The Philippines and Round About: Major G. J. Younghusband (Macmillan).

Serials.—The Paidologist, April (Cheltenham).—Geographical Journal, April (Stanford).—Archives of the Roentgen Ray, February (Rehman).—Engineering Magazine, April (Strand).—Mind, April (Williams).—Journal of the Royal Statistical Society, March (Stanford).

CONTENTS.

THURSDAY, APRIL 20, 1899.

A SCIENCE OF THE SCIENCES.

The Groundwork of Science; a Study of Epistemology. By St. George Mivart, M.D., Ph.D., F.R.S. (The Progressive Science Series.) Pp. xvii + 331. (London: John Murray, 1898.)

INASMUCH as science is an organised knowledge of the phenomena of nature and the laws which govern these phenomena, and since this knowledge is acquired through the senses and interpreted by the intellect of man, it is obvious that the groundwork of science must be sought for in the human mind. To many this may seem a self-evident proposition, but it nevertheless furnishes Dr. Mivart with material for the ten chapters of which the present work is composed. The aim and objects of the book are set forth in a preliminary way in the introductory chapter, from which we give the following extract as fairly representing the author's position:

"It is not enough for the true man of science to be acquainted with many sciences, and to reflect on the knowledge he so possesses. The rational mind sooner or later seeks to know what is the basis of his own knowledge and the ultimate groundwork of all science. It thus calls for a science of science, and cannot rest satisfied without a pursuit of Epistemology, or the study of the grounds of all the learning the mind of man can acquire" (p. 2).

In the second chapter the author sets out with the object of discussing the classification of the sciences, but wisely comes to the conclusion that instead of classifying it is sufficient to simply enumerate the sciences as being the raw material with which epistemology has to deal. The arguments which lead to the conclusion that it is futile to attempt to classify the sciences in any satisfactory way are ingeniously marshalled, and will, we imagine, be convincing to most scientific readers. After all there is only one science of nature; all our divisions are more or less arbitrary, and necessitated only by the finiteness of the human intellect.

In the third chapter, entitled "The Objects of Science," Dr. Mivart discusses at great length the idealism of Bishop Berkeley, to whose influence he traces "the whole of the philosophy of Germany and Holland, from Spinoza to Hartmann." So fairly does the author state the case for the idealists, that the reader might at first be disposed to imagine that Dr. Mivart is identifying himself with that school. It is not till we reach p. 43 that the first breath of realism appears, and from thence on to the end of the chapter we find ourselves in a healthier scientific atmosphere. Here again the arguments used against the pure idealist, although somewhat unnecessarily lengthy, are well considered and cannot fail to leave the reader in a more rational state of mind as regards his scientific position:

"The conviction, then, that science is really concerned not alone with thoughts, but also with external, independent, and extended realities, is so far justified" (p. 64).

Having arrived at this conclusion, and having incidentally (p. 84) disposed of the new Monism, the author sums up the chapter by describing in general terms the objects of science as mental, physical and metaphysical; and in the fourth chapter he discusses the methods of science, which methods are summed up under ten fundamental propositions (pp. 106-107). The author considers that the truth and certainty of these propositions is implied by the methods of science; and we do not suppose that many scientific men will join issue with him here. Some of the said propositions—such as "nothing can at the same time both be and not be" and "some axioms are self-evident"—may appear to many readers as truisms.

In the fifth chapter, having the title "The Physical Antecedents of Science," the author sets out from the proposition that since knowledge consists of mental states or feelings, and since feelings are the result of physical organisation, it is necessary to have an acquaintance with the physiological machinery by which psychical results are made possible. This chapter accordingly deals with what may be described as an outline sketch of classification and morphology with more special reference to the structure of the nervous system of man. In discussing instinct the author states that "instinctive movements differ from reflex actions in that they are not merely responsive to a stimulus felt, but respond to that stimulus in such a manner as to serve a future unforeseen purpose" (p. 127). The same definition is expanded at greater length on p. 132. The sixth chapter discusses the psychical antecedents of science, and opens with the following paragraph:

"The time has now come to leave behind us, as far as may be, questions of mere physics and physiology, and turn our attention to what concerns the declarations of our own consciousness with respect to our feelings and cognitions" (p. 139).

In other words the real business of the book begins here, and the five chapters which the reader is supposed to have mastered by the time he reaches this point must be regarded as dealing more or less with preliminary considerations. One of the main features of this chapter is the discussion of the differences between the lower and higher mental processes, the former comprising mere feelings or sensations, and the latter the intellectual perceptions. It is conceded that the lower psychical faculties exist in animals other than man. It is suggested that the term *consentience* should be applied to the unconscious manifestation of sensuous impulses of diverse kinds in the individual. The question whether animals possess the higher faculties, lower in degree, but similar in kind to those possessed by ourselves, is answered by Dr. Mivart in the negative. He denies them the faculty of reasoning, and the ethical or moral sense, and considers that "consentience" explains all their actions. The human faculty of reason is considered to be different in kind from anything possessed by lower animals (p. 162). In support of this contention some pages are devoted to arguing away those acts of animals which have been and are still considered by many psychologists to be due to intelligence. The subject of instinct is again discussed in this chapter, and the theory of natural selection is considered to be inadequate both for the explanation of the origin of the instincts of

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animals and the "lowest psychical powers" of man. The general conclusion is that there is a distinction in kind between man and animals, and the crucial difference is expressed by the statement that "men speak but animals are dumb." From this we are led to the seventh chapter, on "Language and Science."

Regarding speech, whether expressed by mere sounds, by articulation, or by gesture, as an expression of intellectual faculties of the higher order, the author will not allow that animals possess any power of intercommunication beyond the lower form of emotional language; and he devotes some pages to an adverse criticism of the views of the late Dr. Romanes on this subject. With respect to the origin of language, Dr. Mivart offers no theory of his own, but concludes that intellectual thought was in man antecedent to language; in other words, that thought is the cause of language, and not language the cause of thought. The general idea which the reader will gather from this chapter is that, in the author's opinion, there occur from time to time breaches of continuity or new departures in the order of nature, and that the transition from non-living to living matter, from non-sentient to sentient beings (*e.g.* plants to animals), or from sentient organisms to the intellectual organism, *i.e.* from animals to man, are cases in point.

The eighth chapter is entitled "The Intellectual Antecedents of Science," and begins with a demolition of the ultra-sceptical intellectual nihilist whose mind has no certainty as to the truth of anything which cannot be proved. The author insists

"that the mind of each one of us . . . already possesses absolute certainty about some things, and that his [the reader's] intellect declares that things which are clearly seen to be evident in and by themselves, possess the greatest certainty which it is possible for the human mind to attain to, and that such certainty is abundant" (p. 225).

Further on (p. 227) it is pointed out that this certainty is attained ultimately by thought and not sensation, and that intellectual perception or intuition is the supreme and ultimate criterion of truth. The reality of the ego and the difference between the objective and the subjective is considered to be proved in the former case, and bridged over in the latter by the memory. The power of memory is, in fact, regarded as proof of the continuous existence of the individual and the reality of "objectivity." It is conscious memory which unites the past with the present, and enables the individual to declare "I am." This faculty of conscious memory is considered by the author to be another profound distinction between man and other animals (p. 240).

In the following chapter, which deals with the "Causes of Scientific Knowledge," Dr. Mivart begins by quarrelling with the old statement that "everything must have a cause," which he considers to be quite untenable because it would lead us to "a *regressus ad infinitum*." He replaces the ancient dictum by the statement that we do see "that every change or new existence is, and must be, due to some cause." Presumably this is based on the idea that the question of "causation" only arises when some change or new state in the existing order of things is observed. By "causation" it must be understood that the author means something more than mere sequence; he argues for a "force" or "power" as a primary ultimate idea which cannot be resolved into simpler conceptions (p. 261). This force or power is not physically perceptible by the senses, but is intellectually perceptible. Herein Dr. Mivart of course finds himself in antagonism to Mr. Herbert Spencer. This kind of causation is subsequently (p. 263) exalted into a law—"a necessary and universal truth which carries with it its own evidence"—and out of this law is further evolved the great principle which underlies all science, viz. the uniformity of nature. The reader will at once confront this principle of uniformity with the statements in Chapter viii. concerning the breaches of continuity in the order of nature to which we have already called attention. Was the law of uniformity broken, for example, when "inorganic" matter became living? According to Dr. Mivart discontinuity must be regarded as part of natural uniformity (p. 288).

In this chapter there is discussed also the theory of natural selection in so far as it bears upon epistemology. The author's views respecting the Darwinian theory have long been before the scientific public, and are reiterated in this work in such statements as the following:—

"By this system, then, unreason may be regarded as practically lord of the universe, and the source of all the beauties and harmonies which exist in organic nature" (p. 273).

The inadequacy of natural selection to account for the genesis of our perceptions of an extended external world is considered at some length, and it is contended that there are many other kinds of knowledge or "intuitions" which cannot be attributed to natural selection. The general drift of the chapter may be, perhaps, summed up in the statement that the universe is an orderly and not a disorderly arrangement, and that since order suggests intelligence and reason there is such an intelligence and reason underlying it all. The "breaches of continuity," such as the passage from non-living to living matter, from the insentient to the sentient, from the irrational to the rational (p. 296), are considered by the author to require "an eternal and ever-present reason latent in all the phenomena of which we can take cognisance." It may be added that the combination of hydrogen and oxygen to produce something so very unlike its constituents as water (p. 285), and the discontinuous variations (? monstrosities) treated of by Bateson in his work on variation (p. 288) are pressed into the service as "new departures" calling for special explanation, and so Dr. Mivart slips an external intelligence into the cosmos.

The tenth and concluding chapter is entitled "The Nature of the Groundwork of Science." In discussing the matter of science, or the field wherein scientific workers have to labour, the author comes to some very paradoxical conclusions respecting matter, motion, space and time. The breaches of continuity or new departures again figure as reasons for recognising

"that the universe is pervaded . . . by something which our intellect reveals to us as having necessarily some analogy with our own reason and intelligence, however inconceivably greater it may be" (p. 310).

Besides the physical, there is the psychical subject-matter with which science has to deal; so that, as the author sums it up, the worker in science is concerned with things and thoughts.

Respecting the tools which the science workers must use, there are, of course, only the senses and the intellect. The intellectual weapons are those fundamental principles which were laid down in the fourth chapter, and which are here recapitulated. In this last chapter also there are discussed some highly abstract possibilities as to the structure, composition and nature of the universe—whether there is anything more than an "intelligent energy," whether there is only one "essential kind of matter with intrinsic motion," and so forth. In fact, by ringing the changes upon various possibilities and conceivabilities, the author at this stage makes a strain upon the assimilative faculty of his reader, which will leave the latter in a state of hopeless bewilderment, unless his (the reader's) mental digestion is in perfect working order. The chief definite conclusions which are drawn are that it (the universe) cannot consist of one kind of energy only, that it is impossible that intellect can have been evolved from mere physical force, and that animals show no signs of latent intellectuality. It is further insisted

"that the portion of truth which we are able to attain to in our investigations of the cosmos, is but an unimaginably small portion of the whole" (p. 317);

a statement which will, we imagine, not be seriously challenged by workers in science. To the latter, viz. the science workers, Dr. Mivart devotes some attention in the concluding pages of his book. The narrowing effect of extreme specialism upon the mind is an undoubted evil, as the author points out. But there is the opposite evil of becoming diffuse to the extent of a practically useless attenuation of the mental faculties. Between these two extremes the active worker in modern science will find it difficult to pursue his course if he desires to keep pace with the development of science generally, as well as to advance his own subject in particular.

In a kind of summing-up the author elaborates further his ideas as to the "intelligent activity" which pervades the universe. The results of this activity harmonise with our reason, but yet it acts in ways different to those which we should adopt in order to arrive at similar ends. It is a "non-human rationality" (p. 321). There is no such thing as waste in nature. Dr. Mivart does not say so explicitly, but he implies that all apparent waste is unseen economy. The groundwork of science is defined (p. 322) as:—

"The work of self-conscious material organisms making use of the marvellous intellectual first principles which they possess in exploring all the physical and psychical phenomena of the universe, which sense, intuition and ratiocination can anyhow reveal to them as real existences, whether actual or only possible."

The non-human intellect which pervades the universe is finally put forward as the foundation of the groundwork of science.

We have endeavoured, as concisely as possible, to give an account of the contents of this bulky volume. It is by no means an easy task to act the part of a reviewer towards what professes to be a kind of philosophy of science, since mere dissent from the author's conclusions is not in itself a legitimate ground of criticism. For the philosophical student it may be fairly said that Dr. Mivart has provided material for endless controversy. For the worker in science he has raised many important questions which are well worth pondering over. Of course we agree generally that there is in reality only one science, and that the various divisions are matters of convenience necessitated by limited brain power. There is, in fact, a real need for a science of the sciences or Epistemology, but the treatment of the subject in the present work appears to the writer to be disappointing. There seems to be a continual working up towards some great generalisation which never comes off. There is over-elaboration in some parts of the treatment, and there are sudden jumps in others. The use of "new departures" or "breaches of continuity" as arguments for the existence of an external non-human intelligence appears to be a relapse towards the state of knowledge which interpolated a "guiding spirit," or an "occult principle," or an "innate tendency," to explain anything we did not understand. It is a dangerous principle in science to attempt to hide ignorance by devices of this kind. The coupling of discontinuous variations in animals and plants with the production of a chemical compound having different properties from its constituents as examples of such "new departures" is singularly unfortunate, even from Dr. Mivart's own point of view.

There is much in the work which will repay thoughtful perusal, since any attempt to make scientific workers take a philosophical view of science is to be commended. But the great defect of diffusiveness, which is so conspicuous throughout the book, will, we are afraid, deter many readers from following the author throughout the laboured and reiterated statements which lead up to his conclusions.

R. Meldola.

THE UGANDA PROTECTORATE.

Under the African Sun: a Description of Native Races in Uganda, Sporting Adventures, and other Experiences. By Dr. W. J. Ansorge. Pp. xiv + 355. (London: Heinemann, 1899.)

The complaint has often been made against travellers that in their books they tell us most about the subjects of which they know least. The latest contribution to the literature of the Uganda Protectorate illustrates the truth of this remark. From the list of qualifications after the author's name in the title-page, the book might be expected to prove a valuable contribution to the knowledge of the many obscure diseases endemic in the Uganda Protectorate.

Occasional medical experiences are recorded, but they deal with mere matters of minor surgery. The important problems connected with tropical diseases, to which so much attention is now being devoted, are passed unnoticed. Most of this bulky volume is devoted to experiences in sport, war and civil administration, such as we might expect from a soldier, rather than from a man with a scientific training. The main value of the book is that it gives an account of the Uganda Protectorate and

the Uganda Road between the years 1894 and 1898. It shows that considerable progress has been effected with the railways, that hotel accommodation has been provided at Mombasa, and that the late Captain Sclater's well-constructed road has greatly facilitated communications with the interior. The road, however, has not been of so much use as it might have been, owing to the collapse of the transport service during the past three years. The author's numerous records of massacred caravans, tribal wars, and tragic deaths of Europeans show that the country has not yet reached the peace expected in a British possession.

The most interesting of Dr. Ansorge's medical observations is a note on the effect of poisoned arrows. Four years ago a jubilant telegram announced that one of the doctors of the Uganda staff had discovered a certain antidote for wounds made by these once dreaded weapons. According to Dr. Ansorge's account this was no great medical triumph; for in some cases which he observed the arrow poison was of no serious strength, and left to itself merely set up a slight local irritation.

The book is mainly of interest scientifically, from its side-lights on anthropological questions. Those who advocate the study of anthropology as a branch of political economy may find many examples in support of their case. The following incident may be quoted, as it has a certain anthropological as well as a political significance. The incident occurred during an attack on one of the Kavirondo villages by the Government forces.

"Two little urchins, four or five years old, attempted to escape from one of the gates; but finding the enemy present everywhere they ran round the village along by the trench, trying to find a means of re-entry. In the meanwhile two of our Masai allies had rushed forward from the besieging hordes . . . and darted in pursuit of the two naked urchins, who, turning round and finding themselves hard pressed stopped running and held out entreating hands to their pursuers. The Masai were jerking their spears horizontally, with the peculiar thrusting movement used in striking a victim. Friends and foes stopped fighting to watch this sudden side-act. One of the Masai did not strike his captive, but . . . the other villain poised his spear and struck the poor trembling child full in the chest. As the boy fell backwards in the grass the Masai gave one more lunge with his spear, and then darted back to where our friendlies stood."

The author tells us on the same page as that on which this horrible deed is described, that after the capture of the first village, members of the British force cut off the hands of the enemy "in order more quickly to possess themselves of the coveted iron bracelets."

Vasco da Gama's men collected bracelets in the same way when he visited Mombasa at the end of the fifteenth century; but we thought that method of making anthropological collections was out of date.

The scientific value of this book is seriously lessened by the absence of reference to other literature on the same country. No official Blue Book could ignore other work more completely. This trait seems characteristic of the author's general attitude; for he seldom mentions his colleagues and comrades by name. This isolation lessens the interest of his narrative, while it is fatal to the anthropological value of his book. For instance, Dr. Ansorge tells us that the Wahima are the aboriginal inhabitants of Uganda, and that they were conquered by the Waganda, under whom they took service as herdsmen. But according to the traditions reported by Stanley, and accepted by nearly all subsequent writers, the facts were exactly the reverse. It was the Wahima who conquered the original Bantu inhabitants of Uganda, and by intermarriage with the conquered people formed the Waganda race. Dr. Ansorge may have good reasons for his belief; but he has only himself to blame if his view is dismissed as a simple mistake.

So far, as the author is describing what he has actually seen, he appears to be accurate; but a rash generalisation leads him occasionally into error; as when he tells us that very few natives eat the flesh of the "croc," to use the inelegant abbreviation by which the crocodile is frequently referred to. This expression illustrates the author's literary style. The only element of humour in the book is contributed by some of the involved sentences. The illustrations, however, are often admirable and instructive, especially in the chapter on Kavirondo. But they would have been of more interest had reference been made to Hobley's memoir on the Kavirondo, some of the points in which they illustrate. The photographs are, however, of unequal merit, and some of them are difficult puzzle-pictures. There is, for example, on p. 128 a picture of a native labelled "A Fishmonger": there are no recognisable fish in the picture, and no notice to the effect that goods are kept elsewhere during the hot weather. It would have saved some perplexity if we had been told whether that particular Uganda fishmonger had retired from business, or whether he was sitting on his stock-in-trade. The picture is not self-explanatory.

The last part of the book consists of a reprint of descriptions of the various mammals and insects collected by the author in British East Africa, and of a valuable list of birds by Dr. Hartert. The list includes 216 species, and it gives some idea of the extent of our knowledge of the avifauna of the district, that this extensive collection only includes three new species and one new variety. Dr. Hartert's list is new, but the descriptions of the mammals and insects are reprinted from the technical journals. It would have been more useful if the pages occupied by these quotations had been devoted to some account of the habits of the animals. The technical descriptions are of no interest to the general reader, while the specialist must refer to the original place of publication. But one of the prices paid for competition in systematic zoology is that it too often turns the naturalist into the collector.

OUR BOOK SHELF.

The Wild Fowl of the United States and British Possessions; or, the Swan, Geese, Ducks, and Mergansers of North America. By D. G. Elliot. Pp. xxii + 316, illustrated. (London: Suckling and Co., 1898.)

With this volume the author completes his "trilogy" of popular manuals of American birds of sport; the plan of treatment being the same as in the previous volumes, which have already been noticed in this journal. In the land of their birth the volumes on "Shore Birds" and "Gallinaceous Game Birds" have been received as the standard works for the sportsman and amateur naturalist

on the subjects of which they treat; and there can be no hesitation in saying that the present issue is in all respects the equal of its forerunners. Not only will it be acceptable to American sportsmen, but it will be of still more value to those of their British brethren who are desirous of trying wild-fowl shooting on the further side of the Atlantic.

In the old days the author is of opinion that North America contained more wild fowl than any other part of the world; and it is a matter of unfeigned regret to hear that the great armies of these valuable birds are at the present day represented only by a relatively small number of survivors. If, indeed, active measures are not taken for the protection of such survivors, there is but too much reason to fear that in many districts wild fowl will become as extinct as the bison. It is to be hoped, therefore, that the two Governments concerned will at once take the necessary steps to prevent such a deplorable result.

Not the least important part of Mr. Elliot's volume is to be found in the protest against the excessive splitting characteristic of modern zoological work, especially in America. It may candidly be admitted that in years past zoologists erred in not according sufficient recognition to local races and varieties; but it is equally evident that at the present day the pendulum is swinging too far in the opposite direction.

"I consider it," writes the author, "most unwise and injudicious to create even a sub-species whose only character is that of size, especially when it is attempted to separate birds of different lands which are so exactly alike as not to be distinguished apart till the tape-line is applied; and even then the test fails at times, as they are often found to be of the same dimensions. . . . The fact that a species is found in Europe and America is no reason whatever that the specimens from the two hemispheres must be specifically, sub-specifically, or in any other degree separable, simply because they come from different localities." Although it may be old-fashioned, this (in spite of an illogical statement in the concluding sentence), in our opinion, is sound common sense, and should give pause to some of the species-makers in the States.

The illustrations, for the most part by Mr. Edwin Sheppard, maintain the high standard as regards accuracy of detail of the earlier volumes; but they appear to us somewhat flat and wanting in tone. If we except American peculiarities of spelling, the work is all that can be desired from the reader's point of view; although we note a few misprints, as *ungus* for *unguis* on p. xviii., and gadwell in place of gadwall on p. 278. Moreover (p. 276), the author has not followed the admirable example of Mr. Evans in adopting the spelling *Dendrocycna* in place of the common *Dendrocygna*, whereby a hybrid term is converted into a classical compound. R. L.

An Introduction to Stellar Astronomy. By W. H. S. Monck, M.A., F.R.A.S. Pp. 203. (London: Hutchinson and Co., 1899.)

THE contents of this book are very different from what the title led us to expect. We have failed to discover in what sense it can be regarded as an introductory work, unless it be an introduction to "arm-chair" researches in astronomy, or to the author's views on certain astronomical subjects. A perusal of the book leaves us with the uncomfortable feeling that the author looks upon practical observers as so many of his subordinates, and considers himself in a much better position than they to discuss the results of observations. Accordingly the book deals very largely with the author's opinions, and the words "I think" occur so often as to prove wearisome.

Nevertheless, as is well known, the author is an earnest thinker, and some of his suggestions may be helpful in directing future inquiries. Some of his views, however are not likely to prove acceptable to astronomers who are capable of connected thought as well as of making observations. Among these may be mentioned the idea that the cooling of a star like the sun may result in a star with a spectrum approaching that of Sirius (p. 101), or that some of the different stellar types may be evolved from different kinds of nebulæ (p. 160).

In dealing with matters involving an intimate acquaintance with stellar spectra, the author would do well to make himself familiar with the published photographs, and not to attach undue weight to very broad classifications. It would be greatly to the advantage of readers, too, if some pictorial representation were given of the different stellar types to which reference is so frequently made.

The book furnishes further testimony to the great value of the work of Dr. Isaac Roberts, not only to the science of astronomy, but also for purposes of book illustration.

Electrolysis and Electrosynthesis of Organic Compounds. By Dr. Walther Löb. Translated by H. W. F. Lorenz, A.M., Ph.D. Pp. xiii + 103. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1898.)

IN view of the many interesting results which have recently been obtained by the application of electrolytic methods to organic chemistry, the publication of this little work in the English language is distinctly opportune. As a guide to the literature relating to the electrolysis of organic compounds it will be of especial service to the investigator, containing, as it does, a practically complete list of references to the original memoirs (including patent specifications). The account of the contents of these is, however, generally very brief, in some cases so brief that it amounts to little more than a subject-index. The electrolysis of each compound, or group of chemically similar compounds, is considered separately, and a list of the products obtained under various conditions given. The conditions are not, however, specified in most cases with sufficient exactitude to permit of the repetition of the experiment, even when these conditions are given in the original memoir, and are of primary importance. Greater attention to this point would have considerably enhanced the value of the book, although, of course, it would have added to its bulk. The general impression left by the perusal of this interesting little work is that the whole subject is yet in its infancy, and that the careful study of the influence of E.M.F., temperature, nature of the solvent, and of the electrodes and of other factors on the electrolysis of organic compounds will yield, as in a few cases it has already yielded, most interesting results.

The translation, although on the whole satisfactory, would have been better if the translator had not adhered so closely to the original; "syntheticized" (p. 11), "strong concentrated solutions" (p. 39); and contractions such as "Brown-Walker," "Mulliken-Weems," are not very happy. The electrical nomenclature is also loose: "the potential of the electric current" is written several times when the potential difference between the electrodes is meant, and on p. 1 we find, "Being poor conductors, the alcohols require *strong currents* for their electrolysis," the current here being confused with the potential difference. The translator has added a good index. T. E.

Report of Observations of Injurious Insects and Common Farm Pests during the Year 1898, *with Methods of Prevention and Remedy.* Twenty-second Report. By Eleanor A. Ormerod, F.R.Met.Soc., &c. Pp. viii + 138. (London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd., 1899.)

MISS ORMEROD'S useful reports are too well known to need any commendation from us; and we are pleased to

learn that she proposes to commence a new series with the next volume, with a slight alteration of plan, and to continue the work as long as her health will permit, which all entomologists will hope may be for many years yet. She is also about to issue a general index to the contents of the twenty-two parts of the first series.

Thirty-seven insects of various orders are mentioned in the present report, among the most interesting being fleas, which have been met with in some places in extraordinary abundance; the forest fly, which has latterly been very troublesome in various parts of Wales; and the "murrain worm," or the larva of the elephant hawk moth (*Choerocampa elpenor*), which is said to be the cause of disease among cattle in various parts of Ireland. As this larva is frequently found in plants growing near water, Miss Ormerod suggests that the mischief may perhaps be caused by some poisonous plant, such as water dropwort or water hemlock (*Oenanthe crocata*), growing in the neighbourhood of the plants on which the caterpillars feed.

Notes from a Diary: kept chiefly in Southern India, 1881–1886. By the Right Hon. Sir M. E. Grant Duff, G.C.S.I. In Two Volumes. Vol. i., pp. xii + 373; vol. ii., pp. 373. (London: John Murray, 1899.)

THESE books are the fifth and sixth volumes of notes from the diary kept during the half-century now almost complete, by Sir M. E. Grant Duff. These pages, dealing with the years during which the author was Governor of Madras, are largely filled with extracts from the letters received from friends in Europe and elsewhere, interspersed with interesting information concerning the flora of Southern India.

Many of the items afford evidence of the interest which the author has always taken in botany.

Sir W. T. Thiselton-Dyer and Prof. Asa Gray, amongst others, reaped some of the fruits of this enthusiasm. On February 23, 1884, it is recorded that the former wrote: "Seeds have descended upon us in a perennial shower. The fountain was mostly sealed to us till your vigorous wand smote the rock of seclusion. We have distributed the residue punctually, as you wished." On July 19 of the same year was entered: "By last mail came several pamphlets from Asa Gray, to whom I have been sending Nilgiri and other seeds." Not the least interesting feature of these pleasantly-written experiences are the references to several men of science with whom Sir M. E. Grant Duff has come into contact. One of the most marked characteristics of both volumes is the collection of good stories; some are old friends, it is true, but many are new.

Fertilisers: the Source, Character and Composition of Natural, Home-made, and Manufactured Fertilisers; and Suggestions as to their use for different Crops and Conditions. By E. B. Voorhees. Pp. xiv + 335. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1898.)

PROBABLY more popular text-books have been issued on the use of manures than on any other part of the subject of agriculture. The present book is carefully written. It gives the reader a good general view of the reasons which make it advisable to apply artificial manures to the land, it describes the principal American fertilisers, and offers prescriptions for all American crops. The recommendations have the appearance of being generally theoretical. There is a great lack of examples showing the actual effects under known conditions of different applications of manure. The important subject of the effectiveness of the residues of previous manuring is scarcely touched. R. W.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Further Notes on Recent Volcanic Islands in the Pacific.

IN NATURE (vol. xli. p. 276, and in vol. xlvi. p. 611) I gave notes on an island in the Tonga Group, called Falcon Island, which had risen from the sea as the result of an eruption in 1885, when it was about two miles long and 250 feet high, and which had in 1892 been greatly diminished in size by the wash of the sea.

The site was again examined in 1898 by Captain Field in H.M.S. *Penguin*, and the island has now wholly disappeared, leaving a breaking shoal in its place.

It will be very interesting to watch this shoal in the future and observe to what depth the sea is able to cut it down, if a fresh eruption does not again reinstate it as an island. I have stated my belief that the sea in this part of the ocean is able to cut such a protuberance down to over twenty fathoms. This island will afford an opportunity of testing the facts.

Metis Island, 75 miles N.N.E. from Falcon Island, also a volcanic product, first seen in 1875, has likewise been reduced to a shallow bank, under water, and will furnish another illustration of the erosive powers of the sea.

Metis Island was reported as a rock 29 feet high in 1875, subsequent eruptions raising it to 150 feet; but, from the fact of its total disappearance in twenty-four years, it would seem that it was, like Falcon Island, all ash, with no solid plug or lava. W. J. L. WHARTON.

April 15.

Mosquitoes and Malaria.—The Manner in which Mosquitoes intended for Determination should be Collected and Preserved.

THE widespread interest now being taken by English medical men and others in all parts of the world, in the dissemination of malaria parasites by means of mosquitoes, which would seem to have been placed beyond dispute by the recent researches of Major Ross, I.M.S., in India, and of the Italian school represented by Drs. Grassi, Bignami, and Bastianelli at Rome—an interest due to the fact that, as a price of world-wide empire, the English race suffers more than any other from the malaria scourge—renders it highly desirable that there should be in the British Museum in London a collection of carefully preserved and accurately determined Culicidæ of the world. Such a collection, when once worked out, would be invaluable for settling the identity of any species that might become an object of suspicion, and the specimens composing it would be at all times available for comparison. Most of the existing descriptions of Culicidæ leave much to be desired (having been based too often upon insufficient material), and are but rarely accompanied by figures of any kind. A collection such as is suggested would, however, enable us to amend or amplify existing descriptions: or, if these should be found altogether unrecognisable, to prepare new ones based upon types in satisfactory preservation; it would also be possible to publish coloured or other plates of the more important species. For all these purposes it is absolutely necessary to have specimens in the best possible condition. Like a large number of other Diptera, mosquitoes from various quarters of the globe differ but little in outward appearance, and even to the eye of a Dipterist a *Culex* or *Anopheles* from Calcutta may look remarkably like a specimen from Chelsea. But when it is found that the hæmatozoa of malaria, while capable of development in one or more species of a genus, are not so in others, although closely allied—in view of the hoped-for practical outcome of the present investigations, the necessity for the accurate and trustworthy determination of the species of mosquitoes becomes doubly manifest. Unfortunately (from the present point of view, which is scientific as well as practical), a mosquito is among the most delicate of Diptera, with its wing-veins and legs clothed with scales, which inevitably come off if rubbed, while the legs themselves part company with the body on the slightest provocation. Since it is upon the scaly covering of the mosquito

that we have chiefly to rely for its specific characters, especially valuable features being often furnished by the banding of the legs (and palpi also in some species of *Anopheles*), any method of collecting, preserving, and sending home specimens that does not take account of these points is likely to be of little use.

In November last year, by desire of Prof. Ray Lankester, the writer drew up a series of instructions for the collecting of mosquitoes, which were forthwith printed by the British Museum in pamphlet form, under the title "How to Collect Mosquitoes." Copies of this pamphlet have been forwarded by the Museum to possible helpers in all parts of the globe; while the Colonial Office, which is taking a great interest in the matter, has furnished other copies (accompanied by injunctions to collect) to the medical officers under its control throughout the empire. It is hoped that ere long, in response to these preliminary measures, consignments of properly collected mosquitoes will commence to flow steadily into the British Museum.

The pamphlet of instructions contains a list of the articles required, and a detailed statement of the proper method of collecting, killing, and preserving mosquitoes intended for determination. The most important points in the technique of mosquito-collecting are that the insects, when captured in the open, must be brought home alive in pill-boxes of a special kind, must on no account be put into spirit, but be killed by being placed for a few moments in a cyanide bottle, and then immediately pinned on an exceedingly fine pin (known to English entomologists as a "No. 20"), which, in order to protect the insect's legs, is thrust through a disc of card, the latter being finally supported by being transfixed by, and drawn rather more than half-way up, an ordinary or toilet pin. The pamphlet concludes with directions for the transmission to England of specimens intended for the British Museum. It may be added that copies of the pamphlet can always be obtained on application to the Director, the British Museum (Natural History), Cromwell Road, London, S.W.; while, if further information on any point is desired, I shall be happy to supply it myself.

Unfortunately, widely as the pamphlet has been circulated, it has not yet reached the hands of *all* mosquito-collectors; and I, therefore, avail myself of the present means of making its existence more extensively known, the impulse to do so having been supplied by certain recent arrivals. From the nature of the present movement very many collectors—perhaps the majority—are medical men who, unfortunately, seem endowed with a sort of natural instinct prompting them to preserve everything by placing it in a bottle of spirit or glycerine. Mosquitoes when treated in this manner reach England in sorry plight. Sundry bottles of specimens from the West Indies and the Far East are now before me. The latter are in the worse condition; continual shaking in the course of the long journey home has precipitated most of the legs to the bottom, which is quite covered with them. Since all previous descriptions of mosquitoes, as indeed of all other Diptera, have been prepared from *dried* specimens, a mosquito "preserved" in this fashion must be removed and dried before any comparison can be made of it. Such a specimen, with its scales either washed away or matted, and its body shrunken and shrivelled, is a bedraggled object indeed. There may, perhaps, to some people, be a peculiar appropriateness in the idea that the last state of the sharp-tongued mosquito should be similar to that of a victim of the old-time ducking-stool, but the scientific value of the specimen so treated is little greater than if it had been crushed with the hand.

A bottle of mosquitoes in spirit from one West Indian locality is not only thick with floating scales and fragments of legs and wings, but is also distinguished by a turbidity unpleasantly suggestive of putrefaction.

Another method recently adopted is to dry the mosquitoes and send them home in small tubes containing cotton-wool; the results are nearly or quite as disastrous as when glycerine or spirit is used. It seems to be forgotten that because specimens may be practically perfect when put into a tube, it by no means follows that they will reach London in the same condition. Mosquito legs adhere to cotton wool, and inevitably get pulled off in numbers; while if any space is left between the specimens and the wool, the former by dint of constant shaking become reduced to a sort of coarsely granulated powder. This is the actual condition of two tubes of specimens recently received. As an instance of misdirected energy it may be worth while to quote one collector's description of this method; he writes as follows:—

"I am making a collection for you of all the different mosquitoes that occur here; they are put into a tube after having been killed in the cyanide bottle, a bit of cotton wool pressed against them, and then kept in the exsiccator over anhydrous chloride of calcium—this to free them of moisture, and thus prevent mould; afterwards corked up.

"Upon arrival remove cork and allow the tube to remain a day in a damp chamber; this can be easily made by inverting a tumbler over a piece of wet blotting-paper; the insects will absorb some moisture, and can afterwards be handled without being broken, mounted on cards or otherwise set up."

Now, when it is absolutely impossible to pin specimens, according to the method prescribed in "How to Collect Mosquitoes," there is just a chance that they may reach London in a more or less useful condition if treated as described in the foregoing extract, provided that a plug of *thin tissue-paper* is substituted for the cotton-wool; this plug should be pressed down until it is in close contact with the specimens, while the latter are still soft; the tubes should be as narrow as possible—preferably not more than ⅓ inch in diameter, and must of course be tightly corked; they should be packed in a tin box filled with cotton wool, so as to reduce all shaking to a minimum.

I would, however, strongly urge no one to adopt this method who can obtain the articles necessary for pinning specimens in the manner prescribed in the pamphlet of instructions, since the latter is *the only really satisfactory plan*. Specimens thrown into spirit are absolutely useless; masses of material entangled in cotton are nearly as bad. It is a pity that so much well-intentioned labour should be thrown away.

ERNEST E. AUSTEN.

British Museum (Natural History),
Cromwell Road, London, S.W., April 14.

Sunspots and Rainfall.

THE question of sunspots and air-temperature was recently considered in these columns with the aid of a method in which each month since 1841 (at Greenwich) was first characterised as + or −, according as the temperature was above or below the normal; a year with *more* than the average number of plus months being considered *warm*, and with *less*, cold.

Rainfall data may of course be treated similarly, and your readers may perhaps be interested to see how the method works out in this case. The values are those for Greenwich, extending as far back as 1815; but those previous to 1841 are to be thought less trustworthy than the others. Two sets of averages have been employed for the two periods (before and after 1841).

Taking 5·4 as the average number of wet months in a year for the whole period, and so 27 as the average number in 5 years, let us now consider the five-year groups about maximum and minimum sunspot years, noting how the number of wet months in each of these groups differs from the average.

Max.	5-year group.	Wet months.	Difference from average.
1. 1830	1828–32	33	+ 6 *e*
2. 1837	1835–39	27	0
3. 1848	1846–50	23	− 4
4. 1860	1858–62	27	0
5. 1870	1868–72	25	− 2
6. 1884	1882–86	23	− 4
7. 1894	1892–96	22	− 5
		Sum.	− 9
Min.			
1. 1823	1821–25	32	+ 5
2. 1833	1831–35	34	+ 7
3. 1843	1841–45	31	+ 4
4. 1856	1854–58	20	− 7 *e*
5. 1867	1865–69	34	+ 7
6. 1879	1877–81	30	+ 3
7. 1890	1888–92	26	− 1 *e*
		Sum.	+ 18

A pretty distinct contrast appears in these two tables.[1] There seems to be (at Greenwich) a greater tendency to wetness in years about sunspot *minima*, than about maxima. Thus in seven maximum groups we find only one (*e*) with an excess of wet months; while in the seven minimum groups an excess appears to be the rule, to which there are two exceptions (marked *e*).

[1] A still better contrast, I think, comes out on comparing the five years ending with a minimum, with the five years following a minimum.

With regard to those exceptions, it may be worth noting that the two in the minimum series of groups (viz. the group for 1856, and that for 1890) occur just about the middle of dry periods in the 35 years' cycle of weather.

Now, the *régime* of rainfall is often different in the north and south of this island. A year that is wet in London may be dry in the north, and *vice versâ*. The following figures may throw light on the extent of this.

Compare the annual rainfall at Greenwich, from 1841 to 1897, with that at Rothesay (N.B.), calling each year with excess of rainfall *wet*, and each with deficiency *dry*.

We find a distribution as follows:—

Gr. wet. Roth. wet.	11	Gr. dry. Roth. dry.	19	Gr. wet. Roth. dry.	14	Gr. dry. Roth. wet.	13

Thus the rainfall has been opposite in character in 27 out of those 57 years (nearly one-half).

Now, with reference to the sun-spot cycle, it would appear that at Rothesay, it is the years about *maxima* that tend to be the wetter. I am not at present in a position to treat the Rothesay data as those for Greenwich have been treated above. But let us take the annual rainfall, marking each year as + or −, as that has been above or below the average. Then, taking five-year groups about maxima or minima since the beginning of this century, we get the following tables:—

	Max.	5-year groups.	Wet.	Dry.
1.	1804	1802–1806	2	3 *e.*
2.	1816	1814–1818	3	2
3.	1830	1828–1832	3	2
4.	1837	1835–1839	3	2
5.	1848	1846–1850	4	1
6.	1860	1858–1862	3	2
7.	1870	1868–1872	3	2
8.	1884	1882–1886	3	2
9.	1894	1892–1896	2	3 *e* ?
	Sums.	... ...	26	19

	Min.			
1.	1810	1808–1812	2	3
2.	1823	1821–1825	1	4
3.	1833	1831–1835	2	3
4.	1843	1841–1845	2	3
5.	1856	1854–1858	1	4
6.	1867	1865–1869	2	3
7.	1879	1877–1881	1	4
8.	1890	1888–1892	2	3
			13	27

Thus, in the former case (nine max. groups) there is one valid exception[1] to the rule of a preponderance of wet years; while the eight minimum groups show throughout a preponderance of dry years.

The same thing might be shown with more or less distinctness for other stations in the north.

In the eyes of some, a contrariety in rainfall, like that just indicated, doubtless seems fatal to the idea of sunspot influence. But the best thought in meteorology to-day, if I mistake not, would hesitate to affirm that it is so. The same influence, indeed, acting under different conditions, may produce different and even opposite effects.

Discussing the question of sunspots and temperature in his recent admirable "Traité elémentaire de Météorologie" (1899), M. Alfred Angot points out that the relation is probably a complex one. "On pourrait concevoir," he proceeds, "que les taches solaires influent, par exemple, sur la position des centres de hautes et de basses pressions, et il serait alors facile de comprendre que ces déplacements produisissent des variations de température d'un certain sens dans une region, d'un sens opposé dans un autre, et nulles enfin dans d'autres encore. Il est possible qu'en reprenant ces études dans cet ordre d'idées on arrive a concilier les résultats, contradictoires en apparence, que l'on a obtenus jusqu'ici." The same thing should obviously apply to rainfall.

Is there any evidence that rain-bringing depressions take, on the whole, a more northerly path across this island (in going E. or N.E.) about the time of maxima sunspots, and a more southerly path about minima? Perhaps something of this kind might account for the oppositeness in rainfall we have considered.

[1] The "homogeneity" of the record before and after 1890 seems a little doubtful.

My object in this letter, however, is rather to call attention to facts than to affirm this or that influence as accounting for them, and it is possible that further inquiry might dissipate the notion that sunspot influence is concerned in those phenomena.

Alex. B. MacDowall.

Periodic Tides.

Under the above heading, Prof. A. W. Duff, in Nature of January 12, describes the character of the periodic tides, or secondary tidal undulations, on the eastern coasts of Canada, and offers an explanation for these based upon observations in the Bay of Fundy. Without entering into any discussion of the explanation suggested, I wish to point out that the basis of fact upon which he rests his descriptions for most of the places named, is so meagre and insufficient as to render these dsscriptions quite misleading.

Prof. Duff has visited St. John in the Bay of Fundy, and has had access to the tide gauge there established by the Tidal Survey. The observations at Quaco and on the St. John river are his own. But with regard to the other places mentioned, his descriptions of the character of the oscillations are entirely based upon a few examples of simultaneous tides, in sets of only four days each, published to illustrate a paper of mine in the *Transactions* of the Royal Society of Canada, and reproduced in one of the reports of progress of this Survey. These were selected to show the character of the main tides, without respect to the minor undulations. On one illustration it was even noted that the tides there represented were unusually free from secondary undulations which appear as a rule at that station. These few illustrations cannot, therefore, properly be employed as a basis for a comparative description of the usual character of these undulations; and it is not right to make this use of them when valuable continuous records from recording gauges exist, by which the subject could be investigated thoroughly as it deserves.

The other places outside the Bay of Fundy named by Prof. Duff are all tidal stations of this Survey, which is being carried on by the Department of Marine, under my direction. There are eight principal stations in the region, extending from Quebec to Halifax, and from Yarmouth at the south end of Nova Scotia to the Strait of Belle Isle. In this region, which includes the Gulf of St. Lawrence and the Bay of Fundy, the tides range from the highest in the world to so flat a tide as to be almost inappreciable except at the springs. At these stations, from two to four years of continuous tidal record has already been obtained, accompanied by meteorological returns from ten stations in the region, and supplemented by a complete file of daily weather charts showing the isobars, issued by the Meteorological Service, which is another branch of the Marine Department. At three of the tidal stations themselves a barograph record is also secured. The monthly charts issued by the Hydrographic Office of the United States, which show the tracks of all the important storms, are also available for purposes of comparison. In addition to these principal stations, there are now fifteen secondary stations, which have been in operation for three or four months during the summer season in the Gulf of St. Lawrence and the Bay of Fundy, at which simultaneous tidal comparisons have been obtained on recording gauges.

At some of these stations the secondary undulations are persistent and continuous; at others, they appear about half the time; while at others again, usually towards the head of estuaries, they seldom (if ever) appear.

The excellent field thus afforded for the investigation of the question was pointed out in a "Note" on the subject, communicated by me, in May 1895, to the Royal Society of Canada (*Trans.* Roy. Soc. of Canada, vol. i., Second Series, 1895–96). The question of the origin of these undulations has been examined by Mr. F. Napier Denison, of the Meteorological staff; his endeavour being to establish a relation with the fluctuations of the barometer. With this in view, he has examined some part of the tidal record as above, and also the tidal record from our Pacific coast stations. The results of his investigations, as far as he has yet carried them, are published in the *Proceedings* of the Canadian Institute, Toronto; paper read January 16, 1897. He has also made an investigation of similar short-period undulations in the Great Lakes (see *Proceedings Canadian Institute*; paper read February 6, 1897). This, with the references given by Prof. Duff to his own papers, completes the study yet given to the subject in Canada.

It is unlikely that better conditions exist anywhere than in the region above referred to. Some of the waters are land-locked, some open to the ocean; the great variety in the range of the tide, tending to magnify the undulations where the range is great, and leaving scarcely anything else but these undulations and the effect of storm disturbance, where the tide is flat; the completeness of the meteorological data and the well-charted storm tracks, furnish ample material for comparison. The investigation has not yet been taken up by this Survey, which has to be carried on with so little means and assistance as to confine it at present to the direct practical issues in the preparation of tide-tables, &c. But where such good material exists, it is very unfortunate that descriptions of the phenomena from a few illustrations should be given as an average account of their characteristics, or that conclusions should be founded upon too narrow and incomplete a basis.

W. Bell Dawson,
Engineer-in-Charge of Tidal Survey.

Ottawa, February 10.

Mr. Dawson characterises my letter as "misleading," and yet, in the course of his own letter, quite neglects to point to an incorrect statement in mine. This is certainly unfortunate.

To show how little Mr. Dawson's remarks touch the substance of my letter, permit me to briefly re-state my position. (1) The oscillations are regular where the basin is fairly regular. This is not questioned by Mr. Dawson, and, as regards the Bay of Fundy, it is amply confirmed by my own observations and the records of Mr. Dawson's department. (2) The oscillations are of irregular period in markedly irregular basins, such as the Gulf of St. Lawrence. This is also not questioned by Mr. Dawson. It is founded on records of four days each from seven different points on the Gulf of St. Lawrence (see the Tidal Report referred to by Mr. Dawson and quoted in my previous letter). Mr. Dawson's only criticism is that he has many other records from the same places; but he does not tell us whether they contradict the published ones. It would certainly be surprising if they did. (3) The period is determined by the dimensions of the basin, and can be calculated from those dimensions, as I have tried to show. (4) The cause of the initial disturbance is probably atmospheric. This point is discussed by Mr. Napier Denison in a short but valuable paper that reached me after my first letter was published. Mr. Denison confines his remarks to the cause of the initial disturbance.

That the period of these oscillations should be determined by the atmosphere seems to me quite incredible. It is surely sufficient refutation that, within a radius of twenty miles from St. John, we have three points at which the regular periods are 35 seconds, 12½ minutes, and 43 minutes respectively, and at one of these points the 35-second and 43-minute oscillations coexist.

Perhaps I have misunderstood Mr. Dawson. If his purpose was to call attention to the valuable materials being gathered by the Canadian Tidal Survey, which Mr. Dawson directs, then I must express my hearty approval, and add the hope that the excellent work may continue and receive efficient support. May I add that my interest is not that of a casual visitor to St. John (as implied by Mr. Dawson), but of a Canadian, most of whose life was passed in St. John? A. Wilmer Duff.

Purdue University, Lafayette, Ind., U.S.A.

The Natural Prey of the Lion.

Jean Baptiste Tavernier, in his "Travels in India" (translated by V. Ball, 1889, vol. ii. p. 397), mentions a case similar to what Mr. Crawshay describes under this heading in your last number (p. 558). "At a distance of two or three leagues from the fort [at the Cape], the Dutch found a dead lion which had four porcupine's quills in its body which had penetrated the flesh three-fourths of their length. It was accordingly concluded that the porcupine had killed the lion. The skin is still kept with the spines sticking in the foot." Thereon it is noted by the English translator that "numerous cases are recorded of tigers having died in India from this cause, and also of occasionally having been found when shot to have porcupine's quills sticking in them." The old Chinese motto, "*the hedgehog defeats the tiger*, and the serpent stops the leopard" (in Liu Ngan, "Hwui-nan-tsze," second century B.C.), is probably founded on observations allied to these. Kumagusu Minakata.

7 Effie Road, Walham Green, S.W., April 15.

THE PRESENT STANDPOINT IN SPECTRUM ANALYSIS.

In a former article I referred to some of the difficulties encountered by the earlier researchers in spectrum analysis. In the present one I propose to pass over the history of nearly twenty years' work with all its attendant doubts and difficulties, and deal with what that work has brought us, a perfect harmony between laboratory, solar and stellar phenomena.

It has been proved beyond all question that not only are both fluted (or channelled-space) spectra and line spectra visible in the case of most of the elements, but that many of the metallic elements with which I shall have to deal in the sequel have at least two sets of lines accompanying, if not resulting from, the action of widely differing temperatures.

It is important to mention that the different chemical elements behave very differently in regard to the action of heat and electricity upon them as we pass from the solid to the liquid and vaporous forms; that is, the two different forms of energy are apt to behave very differently, the permanent gases as opposed to the elements which generally exist in the solid form is the first differentiation, the elements of low atomic weights and low melting point as opposed to the rest, is the second.

In the cases in which heat-energy can go so far, we first get an increase in the free path of the molecules, and ultimately the latter are made to vibrate.

In the case of electricity, on the other hand, increase of free path is scarcely involved, and hence we may have effects similar to those produced by high temperature, with scarcely perceptible effects of heat in the ordinary sense.

Conversing on this subject with my friend Clifford, many years ago, we came to the conclusion that the energy imparted to a molecule might cause (1) an extension of free path; (2) a rotation, and (3) a vibration. To get concrete images of these effects we spoke of *path-heat*, *spin-heat*, and *wobble-heat*. The facts seemed to show that heat energy had no effect in producing line-spectra until the two first results had been obtained, and, further, that in all gases and many metals it had no effect in producing vibrations; while, on the other hand, electrical energy generally acted as if it began at the third stage, and is effective in the case of every chemical substance without exception.

However this may be, we now know that many elements present changes at several widely differing stages of heat. The line spectra of elements like sodium, lithium, and others may be obtained by the heat of the flame of a spirit lamp, or an ordinary Bunsen's burner, the substance being introduced into the flame by a clean platinum wire twisted into a loop at the end.

This temperature has no effect upon iron and similar metals. To get any special spectral indication from them a higher temperature than that of the Bunsen is required, the blowpipe flame may be resorted to; in this a stream of air is blown through the centre of a flame of coal gas burning at the end of a cylindrical tube.

We get in this way what is called a "flame-spectrum," in which flutings and some lines are seen. In order to obtain the complete line-spectra of some of the less volatile metals, like iron and copper, we are driven to use electrical energy and employ the voltaic current, and (for choice) metallic poles which are so strongly heated by the passage of the current that the vapour of the metal thus experimented on is produced and rendered incandescent.

We may say generally that no amount of heat-energy will render visible the spectra of gases. These are obtained by enclosing the gases in glass tubes and illuminating them by means of an electric current. We may go further and say that the ordinary voltaic current

used in laboratories is equally inoperative. We must have the induced current, and with different tensions different spectra are produced.

We have then arrived so far. Heat-energy, which does give us line-spectra in some cases when metals are concerned, fails us in the case of the permanent gases and many metals. A voltaic current gives us spectra when metals are in question, but, like heat-energy, it will not set the particles of the permanent gases vibrating.

But when both metals and the permanent gases are subjected to the action of a strong induced current—that is, a current of high tension when an induction coil with leyden jars and an air break are employed, we get this vibration; gases now become luminous, a distinct change in the spectra of the metals is observed, a change as well marked, or perhaps better marked, than any of the previous lower temperature changes to which I have already drawn attention.

When the tension is still further increased, the differences in the spectra are most marked in the case of gases, for the reason that, being enclosed in tubes, they cannot escape from the action of the current; all the molecules are equally affected. *The spectrum is sometimes* NOT *a mixed one.* In the case of the metals the spark is made to pass between two small pointed poles, and the region of most intense action is a very limited one; we get from the particles outside this region the spectrum obtained with a lower degree of electrical energy. *The spectrum* IS *a mixed one.* Even when we take the precaution of throwing an image of the spark on the slit of the spectroscope, the outer cooler layers pierced by the line of sight add their lines to the spectrum of the centre.

Not only so, but the individuality of the various chemical elements comes out in a remarkable manner.

To take one or two instances. I will begin with the gases with a weak and strong induced current. Hydrogen gives us what is termed a structure spectrum, a spectrum full of lines; this changes to a series. Oxygen gives us series which change into a complicated line-spectrum in which no series has been traced. Nitrogen gives us a fluted spectrum which changes into a complicated line-spectrum.

I next pass to the metals, and again, for brevity's sake, I will deal with three substances only. In the case of magnesium, iron and calcium, the changes observed on passing from the temperature of the arc to that of the spark have been minutely observed. In each, new lines are added or old ones are intensified at the higher temperature. Such lines have been termed *enhanced lines*.

These enhanced lines are not seen alone: as in the case of the spark, so in the arc outside the region of high temperature in which they are produced, the cooling vapours give us the lines visible at a lower temperature.

Bearing in mind what happens in the case of the gases, we can conceive the enhanced lines to be seen alone at the highest temperature in a space sufficiently shielded from the action of all lower temperatures, but such a shielding is beyond our laboratory expedients; still, as I shall show, in the atmospheres of the stars we have probably the closest approximation open to our observation of that equally heated space condition to which I have referred.

The enhanced lines are very few in number as compared with those seen at the temperature of the arc. In the case of iron thousands are reduced to tens.

The above statements are only general: if we include the non-metals, more stages of temperature are required, and it then becomes evident that different kinds of spectra are produced at the same temperature in the case of different elements; in other words, at many different heat-levels changes occur, always in one direction but differing widely for different substances at the lower temperatures. At the highest temperatures—at the limit—there is much greater constancy in the phenomena observed if we disregard the question of series. If considered from the series point of view, there is no constancy at all.

It is obvious that with all these temperature effects observed in a large number of elements, very many comparisons are rendered possible. All these suggest that if dissociation is really in question, in some cases, at least more than two simplifications in the line stage are necessary to explain the facts. It is possible that the effects at first ascribed to quantity may be due to the presence of a series of molecules of different complexities, and that this is the true reason why "the more there is to dissociate, the more time is required to run through the series, and the better the first stages are seen."[1]

After this general statement of the changes in spectra observed to accompany change in the quantity and kind of energy used in the experiments, I propose to refer briefly to the most recent work on this subject, touching the changes observed on passing from the arc to the spark in the case of many of the metallic elements. By the kindness of Mr. Hugh Spottiswoode, the photographs of the enhanced lines have been obtained by the use of the large induction coil, giving a 40-inch spark, formerly belonging to Dr. Spottiswoode, P.R.S. I am anxious to express here my deep obligation to Mr. Hugh Spottiswoode for the loan of such a magnificent addition to my instrumental stock-in-trade.

The spark obtained by means of the Spottiswoode coil is so luminous that higher dispersions than those formerly employed can be effectively used, and in consequence of this, the detection of the enhanced lines becomes more easy; their number therefore has been considerably increased.

At the higher temperature enhanced lines have been found to make their appearance in the spectra of nearly all the metals already examined. Lithium is one exception.

Neglecting then all changes at the lowest temperatures, but including the flame spectrum, four distinct temperature stages are indicated by the varying spectra of the metals; for simplicity I limit myself to iron as an example. These are:

(1) The flame spectrum, consisting of a few lines and flutings only, including several well-marked lines, some of them arranged in triplets.

(2) The arc spectrum consisting, according to Rowland, of 2000 lines or more.

(3) The spark spectrum, differing from the arc spectrum in the enhancement of some of the short lines and the reduced relative brightness of others.

(4) A spectrum consisting of a relatively very small number of lines which are intensified in the spark. This, as stated above, we can conceive to be visible alone at the highest temperature in a space efficiently shielded from the action of all lower ones, since the enhanced lines behave like those of a metal when a compound of a metal is broken up by the action of heat.

Each line of each element at whatever temperature it is produced, can at once be compared in relation to position in the spectrum with the lines visible in celestial bodies with a view of determining whether the element exists in it.

At the time at which the earlier inquiries of this kind were made it was only possible for the most part to deal with eye observations of the heavenly bodies. The results were, therefore, limited to the visible spectrum.

During the last few years photographs of the spectra of the brighter stars and of the sun's chromosphere during eclipses have been obtained; it became of importance, therefore, to extend the observations of terrestrial spectra into the photographic regions for the purpose of

[1] *Proc. Roy. Soc.*, 1879, No. 200.

making the comparisons which were necessary for continuing the inquiry.

The recent work has been done with this object in view.

The way in which the enhanced lines have been used is as follows. Those belonging to some of the chief metallic elements have been brought together, and thus form what I have termed a "test-spectrum." This has been treated as if it were the spectrum of an unknown element, and it has been compared with the various spectra presented by the sun and stars.

How marvellous, how even magnificent, the results of this inquiry have been, I shall show later in detail; but I may here say by way of anticipation that the test-spectrum turns out to be practically the spectrum of the chromosphere; that is, the spectrum of the hottest part of the sun that we can get at, and that a star has been found in which it exists almost alone, nearly all the lines of which had previously been regarded as "unknown."

This last result is of the highest order of importance because it should carry conviction home to many who were not satisfied with the change of spectrum as seen in a laboratory, where, of course, the enhanced lines when seen in the spectrum of the centre of the spark have alongside them the lines in the spectrum of the outer envelope, which of course is cooling, and in which the finer molecules should reunite. For twenty years I have longed for an incandescent bottle in which to store what the centre of the spark produces. The stars have now provided it, as I shall show.

Although I have promised to pass over the history of the work generally, I must still point out that the enhanced lines in the test-spectrum actually include all those first studied years ago when everything was dim, and we were seeing through a glass darkly; not as we are now, face to face. To show the rigid connection of the new with the old, it is desirable to refer briefly to some of the work undertaken in relation to some of the first anomalies noted.

One advantage of this method of treatment is that it shows that the immense mass of evidence now available supports all the conclusions drawn from the meagre evidence available a quarter of a century ago.

Some of the anomalies were as follows: they are given as specimens of many.

(1) Inversion of intensity of lines seen under dfferent circumstances.

I showed in 1879 that there was no connection whatever between the spectra of calcium, barium, iron, and manganese and the chromosphere spectrum beyond certain coincidences of wave-length. The long lines seen in laboratory experiments are suppressed, and the feeble lines exalted in the spectrum of the chromosphere. In the Fraunhofer spectrum, the relative intensities of the lines are quite different from those of coincident lines in the chromosphere.

(2) The simplification of the spectrum of a substance at the temperature of the chromosphere. To take an example, in the visible region of the spectrum, iron is represented by nearly a thousand Fraunhofer lines; in the chromosphere it has only two representatives.

(3) In sun-spots we deal with one set of iron lines, in the chromosphere with another.

(4) At the maximum sun-spot period the lines widened in spot spectra are nearly all unknown; at the minimum they are chiefly due to iron and other familiar substances.

(5) The up-rush or down-rush of the so-called iron vapour in the sun is not registered equally by all the iron lines, as it should be on the non-dissociation hypothesis. Thus, as I first observed in 1880, while motion is sometimes shown by the change of refrangibility of some lines attributed to iron, other adjacent iron lines indicate a state of absolute rest.

Laboratory work without stint has been brought to bear, with a view of attempting to explain the anomalies to which attention has been directed.

I only refer here to the work done on iron, magnesium and calcium, to show that in those metals the anomalies were to a large extent due to the lines now termed enhanced—that is, the lines seen to considerably change their intensities when the highest temperatures are employed.

Iron.

In the course of my early observations of the spectrum of the chromosphere, I discovered on June 6, 1869, a bright line at 1474 on Kirchhoff's scale, which I stated to be coincident with a line of iron. On June 26 I discovered another at 2003·4 of the same scale.

The later researches on the spectrum of iron have shown that the iron line which I observed in 1869 to be coincident with the bright chromospheric line at 1474 on Kirchhoff's scale, having a wave-length of 5316·79, is an enhanced line, agreeing absolutely with Young's latest determination of the wave-length of the 1474 chromospheric line.

Similarly the line at 2003·4 of Kirchhoff's scale, with a wave-length of 4924, is also an enhanced line of iron.

The first experiments were made to explain my own and the Italian observations of the chromosphere which proved the presence of only these two lines of iron in the part of the spectrum ordinarily observed; the ordinary spectrum of iron in which 460 lines had been mapped at that time was entirely invisible.

The anomalies were investigated in the experimental work with sparks produced by quantity and intensity coils with and without jars in the circuit. The outcome of these experiments was to show that the chromospheric representatives of iron were precisely the lines which were brightened on passing from the arc to the spark, while the lines widened in spots corresponded to a lower temperature.

The next anomaly observed was that in a sun-spot the iron line at 4924 often indicated no movement of the iron vapour, while the other iron lines showed that it was moving with considerable velocity.

It seemed perfectly clear then that in the sun "we were not dealing with iron itself, but with primitive forms of matter contained in iron, which are capable of withstanding the high temperature of the sun, after the iron observed as such, has been broken up, as suggested by Brodie."[1]

On this view, the high temperature iron lines of the chromosphere represent the vibrations of one set of molecules, while the lines which are widened in spots correspond to other molecular vibrations. Similarly, the idea of different molecular groupings provides a satisfactory explanation of the varying rates of movement of iron vapour indicated by adjacent lines, the lines being produced by absorption of different molecules at different levels and at different temperatures.

Magnesium.

In 1879 I passed a spark through a flame charged with vapours of different substances. In the case of magnesium the effect of the higher temperature of the spark was very marked; some of the flame lines being abolished, while two new ones made their appearance, one of them at 4481. The important fact was that the lines special to the flame did not appear among the Fraunhofer lines, while those of the spark did appear.

This line at 4481 now takes its place among the enhanced lines like those of iron previously mentioned; special cases now form part of the more general one.

Here again the experiments pointed to varying degrees of dissociation at different temperatures as the cause of the non-appearance of some of the magnesium lines in the Fraunhofer spectrum.

[1] *Proc. Roy. Soc.*, vol. xxxii. p. 204.

From these experiments, the results of which were subsequently mapped in relation to the various heat-levels indicated by solar phenomena, I drew the following conclusions in 1879:—

"I think it is not too much to hope that a careful study of such maps, showing the results already obtained, or to be obtained, at varying temperatures, controlled by observations of the conditions under which changes are brought about, will, if we accept the idea that various *dissociations* of the molecules present in the solid are brought about by different stages of heat, and then reverse the process, enable us to determine the mode of evolution by which the molecules vibrating in the atmospheres of the hottest stars *associate* into those of which the solid metal is composed. I put this suggestion forward with the greater confidence, because I see that help can be got from various converging lines of work."

Calcium.

In 1876 I produced evidence that the working hypothesis that the molecular grouping of calcium which gives a spectrum having its principal line at 4226·9 is nearly broken up in the sun, and quite broken up in the spark, explained the facts which are that the low temperature line loses its importance and practically disappears from the spectrum of the sun, in which H and K are by far the strongest lines.[1]

I summed up the facts regarding calcium as follows:[2] "We have the blue line differentiated from H and K by its thinness in the solar spectrum while they are thick, and by its thickness in the arc while they are thin. We have it again differentiated from them by its absence in solar storms in which they are almost universally seen, and, finally, by its absence during eclipses, while the H and K lines have been the brightest seen or photographed."

I afterwards attempted to carry the matter further by photographing the spectra of sun-spots. In all cases H and K lines were seen reversed over the spots, just as Young saw them at Sherman, while the blue calcium line was not reversed.[3] The oldest of these photographs which has been preserved bears the date April 1, 1881.

The experimental results in the case of calcium, therefore, followed suit with those obtained from iron and magnesium, and indicated that the cause of the inversion of intensities in the lines of a substance under different circumstances is due to the varying degrees of dissociation brought about by different temperatures.

Both in the case of iron, magnesium and calcium the high temperature lines involved are not seen at all at lower temperatures, and even in the case of calcium, when photographic exposure of 100 hours' duration have been employed. It should be sufficiently obvious to everybody then that temperature alone is in question.

Finally, then. The similar changes in the spectra of certain elements, changes observed in laboratory, sun and stars are simply and sufficiently explained on the hypothesis of dissociation. If we reject this, so far no other explanation is forthcoming which coordinates and harmonises the results obtained along the different lines of work. NORMAN LOCKYER.

HIGHER COMMERCIAL EDUCATION AND THE UNIVERSITY OF LONDON.

OUR knowledge of what is needed for the improvement of commercial education has undoubtedly been amplified and better defined by the action of the London Chamber of Commerce and of the Technical Education Board of the London County Council. The important conference held in June last at the Guildhall settled certain points beyond further controversy, and cleared the way for a new departure in those directions in which improvement is practicable and possible. The "Summary of Results" published by the Chamber will serve as a useful guide to educational authorities desirous of adapting school teaching to the requirements of our mercantile classes. The special Committee, appointed in May 1897 by the Technical Education Board, were actively engaged during the greater part of the year 1898 in taking evidence from merchants, bankers, teachers, and organisers of commercial classes, and their valuable report, recently published, gives some interesting extracts from the evidence of the expert witnesses they consulted, together with their own conclusions and recommendations. The report also contains a summary of the notices, previously published in various other reports, of the facilities provided in foreign countries for commercial education of different grades.

For many years there has been a growing feeling in this country, that the mercantile classes are placed at a disadvantage in competition with their foreign neighbours, owing to the absence of any specialised schools of commerce, such as exist in other parts of Europe. The reports of our consuls abroad went to show, that in the distant markets of the world agencies were being established with continental manufacturing firms, and that England was being gradually driven to the wall, in consequence of the greater activity, and the special aptitudes of commercial travellers, representing mercantile firms in Germany, Belgium, and Switzerland. It was also shown, that owing to their special business qualifications and to their knowledge of foreign languages, foreigners were preferentially employed in business houses in this country, and it was generally assumed, that although there might be other causes of an industrial and economic character, which helped this result, the defects of our educational system were mainly responsible for the gradual displacement in many important markets of English wares for those produced in other countries.

It is possible there may have been some exaggeration in the facts on which these conclusions were based; but there is no doubt that a strong *à priori* case for inquiry was established, and the report of the London County Council, and of the conference at the Guildhall, supplemented by further evidence from our consuls, and from other persons who have independently investigated the subject, has shown the extent to which foreign nations have benefited by their special schools, and the directions in which improvements may be looked for in our own methods. A very important item of evidence was furnished by Mr. Powell in his consular report on this subject of November 1898, which has undoubtedly modified the views of some of our educational reformers. Mr. Powell brought into prominence the fact, that the alleged pre-eminence of Germany was in no way due to her commercial schools; but that the movement, now in progress, for developing commercial education had followed, and had not preceded the rapid advance in her industrial operations. The wide publication of this fact has been useful in directing attention to other causes than the absence of special commercial schools in this country, for the explanation of the undoubted ability of German clerks and commercial agents to succeed where Englishmen too often fail. The inquiry instituted last year will serve to prevent the repetition of vague statements about the comparative excellence of commercial schools abroad, and shows the extent of the changes that are needed in our present educational system to give us all the advantages that commerce can be expected to gain from special schools or new methods of instruction.

The recommendations in the report of the London County Council are in general agreement with the con-

[1] *Proc. R. S. Proc.*, vol. xxiv. p. 352. [2] *Ibid.*, vol. xxviii. p. 171. [3] *Ibid.*, vol. xxxvi. p. 444

clusions of the conference, and deprecate any attempt to teach the practice of commerce as a part of general education in any of our secondary schools. The language of some of the recommendations in the report of the County Council is perhaps a little misleading, owing to the fact, that where the report speaks of "commercial education," what is really intended is "training adapted to commercial life"; and from the evidence given in the report, and emphasised at the conference, such a training should be general rather than special, and the subjects of instruction should be so taught as to encourage independence of thought and the power of original investigation. It is the habits that such a training affords rather than any special knowledge, beyond that of foreign languages, that have helped the German schoolboy, and cannot fail to prove useful to the future business man It is important, however, that the education should be of a modern type. Physical science, including geography, mathematics and drawing, English composition and modern languages, should form the principal subjects of instruction in our secondary commercial schools; but the subjects should not be taught with any special view to mercantile practice, but by scientific methods equally applicable to the study of other subjects, and to the instruction of pupils destined for other occupations.

It is recognised that in all schools above the primary, different weight may be given to different branches of study, and that the teaching, even on the modern side, may be differentiated without being specialised. But the basis of such an arrangement should be found in the different amount of time given to the different studies, and not in the introduction of any specialised teaching. For instance, whilst the prevalent system of teaching foreign languages to all classes of pupils is generally recognised as susceptible of improvement, it will be readily admitted that pupils on the commercial side of a school might devote more time to the study than those intended for the medical or engineering professions. It is equally evident that the experimental method of teaching elementary science, as sketched out in the regulations of the Joint Scholarships' Board, are serviceable not only, nor indeed especially, to future technical students, but equally to all boys and girls, whatever the career they may eventually follow. Indeed, recent inquiries at home and abroad have shown the desirability not only of improving our methods of school teaching, but also of introducing system into our school organisation. It is mainly owing to the absence of any distinct aim or purpose in the teaching given in so many of our schools, that the secondary education of this country fails to satisfy the requirements of persons training for different careers, or to afford a fitting preparation for the different branches of industrial life. Suggestions with a view to the organisation needed are contained in the County Council's report; and it is hoped that when the machinery contemplated in the new "Board of Education Bill" shall be completed and in good working order, our secondary education may be sufficiently elastic to adapt itself to the various wants of industrial life. This is evidently what Prof. Hewins refers to when he says: "The most serious difficulty that has to be dealt with in the organisation of commercial education is to be found in the unsatisfactory state of secondary education in England."

One thing, recent inquiries will certainly have shown, viz. that in its higher developments the theory of business is a subject capable of being treated as a branch of higher education; and those who read the reports of the conference and of the Technical Education Board's Committee will find no difficulty, as regards trade, in agreeing with what Emerson wrote nearly sixty years ago: "I look on trade and every mechanical craft as education also."

It is, however, in the University stage of education, if anywhere, that specialisation with a view to a commercial career seems to be justified. The conditions of modern trade and commerce show, that for those who are to direct industrial concerns, and equally for those who are to discharge the important functions of consuls in different parts of the empire, the ordinary education of a good public school, even on the modern side, needs to be followed up by a special training in the theory of commercial science. It is well known that for many years excellent schools of this higher type have flourished in France, Belgium and Italy, and more recently in Switzerland. In Paris there are two institutions, one established by the Chamber of Commerce and another by private enterprise, in which commercial education of university grade is given. These institutions are well attended, the age of the students ranging from sixteen years upwards. It is true that the recognition of these schools by the State, as exempting the students from a part of the obligatory military service, has had an important influence upon the attendance, parents preferring that their sons, destined for a commercial career, should spend two years in a school of commerce than in barrack life. But, apart from this consideration, there is no doubt, that in France and Belgium, the value of a special commercial training for youths over sixteen years of age, before going into business, is fully recognised by merchants and bankers. In Germany, too, the recent establishment of a High School of Commerce in connection with the University of Leipzig, is strong evidence of the importance, which those who may be regarded as the best educational authorities in Europe attach to such specialised teaching.

In London, the great success of the School of Economics, under the direction of Prof. Hewins, has shown that studies connected with the business of commercial life admit of being treated in such a way as to claim recognition as part of a university education. No one can look through the general course of study pursued in that school, in which there are now over four hundred students, without coming to the conclusion, that the aim of the teaching is distinctly educational and scientific, and that the students' work is such as demands the exercise of intelligence and thought, leading up to practice in methods of investigation and research. What was previously regarded as merely possible and advisable, viz. the treatment of economics in relation to the theory of commerce, as a subject of university training, has been proved to be both practicable and useful. By higher commercial education is now understood a system of education "which provides a scientific training in the structure and organisation of modern industry and commerce, and in the general causes and criteria of prosperity, as they are illustrated or explained in the policy and experience of the British Empire and foreign countries." Among the subjects which such a course of education embraces, and in which fresh investigations are encouraged, are the study of statistics with application to the machinery of business, including banking, insurance, the theory of exchange; transport and the means of communication; industrial law, factory and other legislation, and the principles of international law; the history of economics and trade; commercial geography including trade routes; systems of taxation; the study of commodities, &c. The machinery of modern commerce offers any number of applications of the general principles underlying the consideration of such subjects; and what is usually understood by university education is well exemplified in the serious study of the facts, which the careful investigation of the phenomena bearing upon these matters helps to elucidate. It is in this spirit of inquiry that the course of instruction at Leipzig and in London has been arranged; and a glance at the programme of either of these schools will serve as a sufficient reply to those, who are disposed to question the

possible connection between the practice of business and the academic training which we associate with university education.

The London School of Economics has had, so far, a very successful career. In its temporary home in Adelphi Terrace are found lecture-rooms and class-rooms, in which a staff of over twenty teachers give instruction; also a well-furnished library containing over 10,000 volumes on economic subjects. The growing importance of the study of economic science in its relation to international trade and commerce, and the success of the attempt to establish in London a special high school for the teaching of the subject will be regarded as justifying the University of London Commissioners in recommending the addition of a faculty of economics to the other faculties of the University; and it may reasonably be hoped that the present school will in the near future be greatly developed, and become more closely associated with the new University.

To many persons it seems highly desirable that the economic and commercial faculty of the new University should be located in the Imperial Institute. The well-arranged collections of Indian and Colonial products, which form a most important part of the equipment of that institute, would be found of especial value in illustrating the teaching of that branch of commercial education known as *Waarenkunde*. Nowhere else in London do similar facilities exist for instruction in the technology of commercial products. Within the building, too, has been provided a chemical laboratory, which is now largely used for the examination and analysis of foreign products; and much of the scientific investigation, therein carried on, under the able direction of Prof. Dunstan, is an essential feature in the programme of a high school of commerce. Indeed, a large part of the work which entered into the original scheme of the promoters of the Imperial Institute, might, it would seem, consistently, and with great advantage to the public, be continued in that institute under the auspices of a school of economics, industry and commerce, in connection with the reconstituted University of London. Whether such an arrangement can be effected is a matter for careful consideration; but there is no doubt that the association with the new University of a school of "economics and political science," under a separate faculty, suggests a reasonable basis of union between the educational side of the Imperial Institute and the future University of London.

As a consequence of the proposed recognition of economics and commerce as a separate faculty of the University, the London County Council have offered, under certain conditions, to allocate to its maintenance a yearly sum of 2500*l*., being part of their promised contribution to the funds of the University. By the aid of such an endowment, increased as it probably will be from other sources, the present School of Economics might enter upon a wider sphere of usefulness with new resources and facilities for advanced teaching, and might become a very important part of a teaching university.

It is now generally understood that a modern university must differ in many essential features from the university of former centuries. Such a university must gather up not only the wisdom stored of ages, but the newest knowledge in its application to the industrial requirements of modern life. The indebtedness of pure science to the investigations and experiments of astronomers, physicians and engineers is generally recognised, and shows how inquiries originally undertaken with a view to some practical end have often led to the discovery of new scientific truths. What is true in physical science is found to be the case also in economic science; and the establishment of a school for inquiry into economic and industrial phenomena; the better definition of our existing knowledge of the subject for the purposes of instruction; the organisation of systematic methods of investigation and research; and, above all, the recognition of the teachers, as constituting a separate university faculty, with common aims and objects, will certainly give a new impulse to the study of the laws of productive industry, and will add largely to our knowledge of the conditions under which trades are fostered, and nations are able to compete with one another in the struggle for new markets.

The establishment of a Faculty of "Economics and Political Science (including commerce and industry)" by no means implies the granting by the University of a corresponding degree. A University degree in any faculty is only supposed to indicate that a student has undergone a systematic course of instruction in a certain department of knowledge, and the precise title of the degree is a matter of comparative indifference. It is essential that, in any new university, there should be distinct and separate avenues to a degree, through the study of the special groups of subjects, in which the student elects to receive his training; and it is enough that the degree should certify that he has undergone such a training. There is no necessary connection between a faculty and a degree. In London, a candidate can take the M.B. or B.S. degree in the Faculty of Medicine, and the M.A. or D.Lit. in the Faculty of Arts. In the Faculty of Science, there are already several different paths along which a student may proceed to graduation, and it is a matter of no great moment whether students in the Faculty of Economics should take the B.Sc. degree, or whether a new title should be invented. Indeed, it may be hoped that, both in engineering and in economics, considerable freedom will be given to the recognised teachers of the university, and that different combinations of subjects, provided they involve an equivalent academic training, will be accepted by the Academic Council of the new university for the degree examination.

The existence in London of a high school of commerce in close connection with the reorganised university, will not only give an impetus to the study of subjects bearing directly upon the development of our manufacturing trades and commerce, but will exercise an important influence upon the curriculum of our secondary and higher grade schools. As the "Board of Education Bill" provides, in the first place, for the organisation of the central authority and of the Consultative Committee, and leaves to a later date the constitution of local authorities, so it will be found that, if a commercial school of university rank is successfully established, the first step will be made towards the organisation of a system of commercial education for schools of a lower grade.

The proposal of the Statutory Commissioners to establish a Faculty of Economics and Political Science in connection with the new university, is the opening of a new era for commercial education in this country; and the recommendation will be welcomed, as showing that the Commissioners fully recognise the importance of bringing the new University of London into close relation with the varied educational requirements of the present day.

Philip Magnus.

WILLIAM RUTHERFORD.

THIS distinguished physiologist was a son of the border. He was born at Ancrum in Roxburghshire in 1839, and he died in Edinburgh on February 21, 1899. About thirty-six years of his busy life, from the date of his graduation in 1863, were spent in the pursuit of physiological science. After studying at Berlin, Vienna, and Paris, he became assistant to the late John Hughes Bennett, who then filled the chair of Physiology in Edinburgh. For many years Bennett had taught histology and the use of the microscope to voluntary classes, and among his pupils may be mentioned the well-known

names of Redfern, Carter, and Dobie, who have each made their mark in this branch of science. It was not, however, until the early sixties that practical physiology, as now understood, was developed in the Edinburgh school. Bennett's great contemporary, John Goodsir, the anatomist, brought under his notice the new experimental school of Germany, and in a short time the ingenious instruments of Helmholtz, Du Bois-Reymond, and Ludwig made their appearance in Edinburgh, probably before they were known in any other school in Great Britain. The first assistant who dealt with such matters, and who added a short course of instruction in physiological chemistry, was Dr. Argyll Robertson, the eminent ophthalmologist. After him came Rutherford, who threw himself into the work with characteristic ardour, and who amplified the course from year to year. In 1869, he became Professor of Physiology in King's College, London; in 1871, Professor of Physiology in the Royal Institution of Great Britain; and, in 1874, he returned to Edinburgh to occupy the chair of his old master. For twenty-five years he laboured unremittingly as a teacher, and he was able, as few men could have done, to cope with the enormous classes which for several years characterised the Edinburgh school. During the winter session, the systematic class frequently numbered five hundred students, while about two hundred and fifty obtained instruction in practical physiology, partly in the winter but mostly in the summer session.

It has always been the tradition that the occupant of a Scottish chair is expected to do two things: he must, in the first place, be a successful teacher, and, in the next, he must contribute to scientific progress; and it may be at once said that many eminent men have not found the two classes of duties to be incompatible. Rutherford is a typical example of such a successful combination, although, no doubt, he will be best remembered as a teacher. In this department of his work he was indeed a master. No one understood better the arts of clear exposition and of successful demonstration. It may be said his lectures were demonstrations from beginning to end. He devised ingenious methods by which fundamental phenomena might be successfully shown to large numbers of students, and his lectures were always copiously illustrated by diagrams. He did not trust much to text-books, nor to students finding out for themselves by laboratory work. He believed that the average student requires to be guided; that he must have the subject placed before him in such a way that he can grasp its leading principles; and that, without careful supervision and almost elementary drill, he will probably lose time in bungling laboratory work. Rutherford, therefore, took immense pains in leading the student on step by step, both in systematic teaching and in the laboratory. It is probable that from the highest point of view he erred in his method, or, rather, carried it too far, but he was eminently successful in training the average man.

Recognising that physiology is a composite science, a science that rests on the triple foundation of anatomy, physics, and chemistry, his own predilections were towards the first. He was thoroughly conversant with histology, as a branch of anatomy, and in his lectures perhaps undue prominence was given to this subject. He spent more time than was necessary in minute morphological details, with the physiological significance of which he was unacquainted; but he held that physiology must begin with an intimate knowledge of the structure of the cell and of the fibre. In this he was right. Histology, for ordinary students, must be taught from the physiological standpoint, but it is high time that the physiologist was relieved from teaching the technique of the subject. Rutherford's earlier training prevented him from grasping with equal firmness the applications of chemistry and physics to physiological problems. Here he was not so much at home. It only remains to be said that, taking him all round, he was one of the most successful teachers that ever adorned the northern school.

As an original investigator, Rutherford accomplished not a little, although it must be admitted that the time he devoted to teaching was often at the expense of that which might have been given to original work. It is also too true that when we sum up a man's work, as a rule it seems insignificant. Even the most skilled and diligent labourers lay only a few stones in the building of the temple. Rutherford did good service to histology by the invention of the freezing microtome, an instrument, however, that has served its day, and, except for special work, must give place to more modern and better methods. In his earlier years he paid much attention to electro-physiology, expounded electrotonus, and discussed various points connected with the excitability of nerve. One of his most important communications was made in 1870, on the influence of the vagus on the circulation. From 1872 to 1879 he laboured much on the physiological action of drugs on the secretion of bile, an investigation originated during Bennett's life-time, and then carried on largely by Rutherford and Dr. Arthur Gamgee. Rutherford, in his later researches, and assisted by a young Frenchman, William Vignal, went over the old ground, and extended its area. He investigated the subject by a most laborious and troublesome method, and no doubt laid solid foundations for our knowledge of the actions of various substances on the formation of bile. This work, owing largely to the unreasonable criticisms of those who objected to observations on animals, was the cause of much annoyance and worry, embittering for a time his social life, while it did not bring to him the credit that subsequent years will show it deserved.

In his later years, Rutherford expounded a theory of muscular contraction that has excited not a little attention, and given rise to much criticism. He was also much interested in the question of the functions of the cochlea in the appreciation of tone, and he advanced the "telephone" theory in opposition to the analytic theory of Helmholtz. Latterly he had grave doubts of the accuracy of Johannes Müller's doctrine of the specific energy of nerves, and had he lived he would probably have written on this subject.

Rutherford was a man of strong personal characteristics. A mannerism impossible to describe, acquired in early manhood, became a second nature, and was at first repellent and liable to be misunderstood. If his criticisms were sometimes severe, his scorn of an opponent scathing and bitter, and his assumption of dignity bordering on the grotesque, those who knew something of the inner life were aware that he did good by stealth, and that behind all the formality there was a simple, kindly nature. Animated by a deep love of science, possessed with a sense of duty that was unsparing in its demands on all his energies, imbued with a love of the beautiful that found its delight in painting and music, a warm friend, a stern and unyielding foe, as if some of the blood of the old borderers lingered in his veins, Rutherford was a man who made his mark, and who will not soon be forgotten.

J. G. M.

NOTES.

A fine monument of Pasteur was unveiled at Lille on April 9. The new buildings of the Pasteur Institute at Lille were opened on the same day.

Sir Richard Thorne Thorne, K.C.B., F.R.S., has been elected a member of the Athenæum Club, under the rule which empowers the annual election of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

The Council of the Iron and Steel Institute has received the intimation that Her Majesty the Queen will be graciously pleased to accept the Gold Medal of the Institute, founded by Sir Henry Bessemer. The first duty of Sir William Roberts-Austen, on taking the chair as president of the Institute on May 4, will be to express the great satisfaction with which this announcement will be received by metallurgists throughout the empire. A main feature of Her Majesty's reign has certainly been the extraordinary development in the production and application of steel.

Active efforts are being made to secure the establishment of a zoological garden in Edinburgh. The committee that has the matter in hand have decided to approach the Government with a view to ascertaining whether a piece of ground for the proposed garden can be obtained within the Arboretum.

The relations of the Society of Chemical Industry to chemical engineering and to industrial research will form the subject of an address to be delivered on Monday next by the president of the Society, Mr. George Beilby.

We regret to see the announcement of the death of Sir William Roberts, F.R.S., the well-known consulting physician. From an obituary notice in the *Times* we learn that he was born on March 18, 1830, and educated at Mill-hill School and at University College, London. He was made a Fellow of the Royal College of Physicians in 1866, when he was selected to deliver the Goulstonian lectures, and he also delivered before that college in the year 1880 the Lumleian lectures, choosing for his subject "The Digestive Ferments and Artificially Digested Food." In continuation of his work in regard to the function of digestion he delivered a series of five lectures at Owens College, Manchester, in 1885, on "Dietetics and Dyspepsia." These two courses of lectures, with other contributions on cognate subjects, he re-issued in a collected form a few years ago in a book entitled "Digestion and Diet." In 1892 he was appointed Croonian Lecturer of the College, and delivered a course of three lectures on the "Chemistry and Therapeutics of Uric Acid, Gravel, and Gout." In 1897 he gave the Harveian oration before the college, delivering an address on "Science and Modern Civilisation," in which he embodied and epitomised the results of the labour and thought of many years. In 1877 he was elected a Fellow of the Royal Society, and in 1879 the Cameron prize was awarded to him by the University of Edinburgh in recognition of the value of his investigations on the subject of the treatment of digestion as a scientific contribution to practical therapeutics. In 1892 he became a member of the Senate of the University of London. He was appointed medical member of the Royal Commission on Opium in 1893, and contributed a memorandum on the general features and the medical aspect of the opium habit in India, which was published as an appendix to the report of the Commission. In 1896 he was appointed to represent the University of London on the General Medical Council. His last official appointment was in connection with he movement to establish a teaching University in London. When by Act of Parliament a statutory commission was ppointed to initiate such an institution, he was selected to serve on that commission as representing, with Dr. Michael Foster, the interests of science and medicine.

A meeting of the Institution of Mechanical Engineers will be held on April 27 and 28. Sir William H. White, K.C.B., F.R.S, president of the Institution, will occupy the chair on both days, and will deliver his address at the first meeting. On April 28, a paper by Mr. H. G. V. Oldham, on evaporation condensers, will be read.

As already announced, the annual meeting of the Iron and Steel Institute will be held on Thursday and Friday, May 4 and 5, commencing each day at 10.30 o'clock a.m. The following are the subjects and authors of papers to be read and discussed during the meeting:—The diffusion of iron, Prof. J. O. Arnold and Mr. A. McWilliam; on the Gellivare iron ore mines, Mr. H. Bauerman; the use of blast-furnace and coke-oven gases, Mr. E. Disdier; the Wellman tilting furnace, Mr. A. P. Head; the solution theory of iron and steel, the Baron H. Jüptner von Jonstorff; exploring for iron ore with the magnetic needle, Prof. H. Louis; theories and facts relating to cast iron and steel, Mr. Bertrand S. Summers; the manufacture of steel direct from the ore in the blast furnace, Mr. D. Tschernoff; the use of hot blast in the Bessemer process, Prof. J. Wiborgh.

The death is announced of Dr. William Frazer, one of the most prominent members of the medical profession in Ireland, and an eminent authority on Irish antiquities.

We learn from *Science* that the Union Pacific Railway has offered to transport geologists and palæontologists without charge from Chicago or San Francisco to Wyoming, for the purpose of making explorations during the coming summer.

Dr. Martin, who is now in Siberia investigating the recent reports regarding the fate of the Andrée expedition, has sent Prof. Nordenskjöld a telegram in which he states that they are without foundation.

The *British Medical Journal* states that the council of the medical faculty of Bucharest has expressed its approval of a scheme for the establishment of a new institute of bacteriology and experimental medicine in that city. It is proposed to place Dr. Cantacuzino, at present assistant in the Institut Pasteur of Paris, at the head of the new institute.

The Trout Fishing Annual Close Time (Scotland) Bill was read a second time in the House of Lords on Tuesday. The object of the Bill is to establish a close time for trout in Scotland, during which period it will not be legal to fish for or take trout in any lake, river, or loch in Scotland by net, rod, or line, or to have possession of such trout, or expose them for sale. The period proposed for the close time is to begin on October 15, and to end on February 28.

The King of the Belgians, as Sovereign of the Congo Free State, has contributed 200*l.* towards the establishment of the London School of Tropical Medicine and the enlargement of the Branch Hospital of the Seamen's Hospital Society. The Archbishop of Canterbury has also contributed 50*l.* to the same object. Lord Lister, P.R.S., is to be the principal guest on the occasion of the inaugural dinner in connection with the Liverpool School for the study of tropical diseases on Saturday, April 22. A sum of 1700*l.* has been promised towards the expenses of the Liverpool School.

The seventy-first meeting of German Naturalists and Physicians will be held at Munich on September 18-23. Prof. Boltzmann, Vienna, will deliver a lecture upon a subject not yet announced; Prof. Forster, Berlin, will describe some of the changes in astronomical thought during the present century; and Dr. Nansen will give an account of explorations of the north polar regions and the results obtained. In medicine, Dr. V. Bergmann, Berlin, will discourse on the value of radiography in surgery; Dr. Birch-Hirschfeld, Leipzig, on science and medicine: and Prof. Dr. Klemperer, Berlin, on Liebig and his influence on medicine. General meetings of the Association will be held on Monday, September 18, and Friday, September 22.

At a meeting of the general committee of the National Sea Fisheries Protection Association, held on Tuesday, it was resolved: "That representation be made to Her Majesty's Government urging the necessity of telegraphic communication with the Faröe Islands and Iceland, and requesting them to join other Powers in subscribing the amount asked for by the Great Northern Telegraph Company of Copenhagen as an annual subscription for the transmission of meteorological and other Government information; and to appoint a representative to attend the Meteorological Congress to be held in St. Petersburg in August next."

The third plague epidemic, which has caused the most terrible ravages in Bombay, is, happily, on the decline. Referring to the mortality which has marked its progress, the *Times* states that five weeks ago the populace were dying at the rate of 350 daily. At least 250 of these deaths were due to the plague. During the past week, however, the hot weather has set in steadily, and the plague generally retreats before a sustained high temperature, the decline being immediately noticeable when the thermometer verges upon the nineties. On Monday the mortality fell to 193, of which probably about 100 were plague cases. As to the protective value of inoculation against plague, it is stated that in the town of Hugli 33,000 persons were inoculated with the Haffkine fluid, while 6000 remained uninoculated. In one week there were 371 deaths among the uninoculated, while only 41 occurred among those who had been inoculated. All inoculations were voluntary. The results obtained from Prof. Lustig's curative serum are, however, unfavourably reported upon by the municipal commissioners of Bombay.

Whether the pen be mightier than the sword is not for us to discuss at the present moment; but that the camera is mightier than the pen, and follows very closely after the sword, will be conceded when the eye glances over the snap-shots taken during recent campaigns. We learn now that the United States Government is very wide awake as to the advantages of photography for recording events of national or historical interest. According to the *British Journal of Photography* (April 14), the U.S. War Department has undertaken the compilation of a photographic history of the war with Spain. To ensure the thoroughness of the scheme, a circular letter has been addressed to all the officers in the service, asking them to contribute such prints, films or negatives as they may have in their possession, promising to return such loans in good condition. It is further requested that the names of all persons who were known to have carried cameras in the regions of active operations should be communicated, so that their aid might be obtained in completing the record. It is proposed to produce in a single volume every obtainable feature and photograph bearing on the subject; and as it is generally known that the camera was extensively used, the publication of such a volume will be looked forward to with great interest.

Bulletin No. 3 of the Blue Hill Meteorological Observatory contains an account, by Mr. S. P. Fergusson, of the progress of experiments with kites during the years 1897–8, with photographic illustrations of the beginning of an ascent, of the steam power windlass, and of kites carrying meteorograph. In 1884, Mr. D. Archibald succeeded in elevating anemometers to a height of 1500 feet in this country. Mr. W. Eddy devised a simple but efficient kite, about ten years later, which reached a height of about 2000 feet. Since that time the work at Blue Hill, under the able superintendence of Mr. A. L. Rotch, has steadily advanced, until within the last two years the meteorographs have been repeatedly carried to heights exceeding 10,000 feet. The greatest height was reached on February 28 last, viz. 12,507 feet, by means of the Hargrave kite, with improvements by Mr. H. H. Clayton; this pattern being the most stable of those in use, has been adopted in all experiments since the spring of 1897. The vertical height is computed by means of the formula

$$H = (\sin h)\, lx,$$

in which H represents the height; h the angular altitude above the horizon, obtained by observing the kite with a surveyor's transit placed near the windlass; l the length of the line, read from the dial attached to the windlass; and x is a constant quantity determined experimentally as a correction for the sag of the line, &c. This computation is made in about a minute, and the results are accurate within one per cent. Kites are much less expensive than balloons, and the exposure of the instruments is better than can be obtained in manned balloons.

Mr. F. Napier Denison has made a special study of the minute undulations recorded upon the self-registering tide gauges, and has compared them with the curves of the self-registering barographs for a number of points on the Atlantic coast of Canada, and within the Gulf of St. Lawrence and the smaller bays. He finds that these minute undulations in the water are due to the direct action of atmospheric waves or billows, or, more properly speaking, oscillations of barometric pressure passing over the harbours and bays. Prof. Cleveland Abbe, the editor of the U.S. *Monthly Weather Review*, suggests that it would be much better to study the barometric oscillations directly as a meteorological problem, and, subsequently, to study their effect on the tides as an oceanic problem; but Mr. Denison recommends the reverse order of treatment. Mr. Denison's last paper appears in the *Proceedings* of the Canadian Institute for November 1898.

A note by Prof. H. V. Hilprecht, in the *Bulletin* (January) of the Free Museum of Science and Art, Philadelphia, states that the new Babylonian expedition of the University of Pennsylvania resumed active work a short time ago. The excavation of the lowest strata of the temple of Bel or Enlil—"the father of the gods"—the exploration of certain quarters of the ancient city proper, and the determination of the precise site of the chief gates of Nippur, form the chief task of the expedition at present. A small number of generous and intelligent citizens of Philadelphia have provided the necessary means for a two years' campaign in Babylonia, with Prof. Hilprecht as scientific director, and Dr. J. H. Haynes as the director of operations in the field. It is hoped that the expedition will settle a number of vital archæological and chronological questions.

At a meeting of the Royal Statistical Society, held on April 18, Mr. Martineau read a paper on the "Statistical Aspect of the Sugar Question." He began by pointing out that though this question originated some thirty years ago with the bounty on the exportation of refined sugar from France and Holland, it had now been extended to the general consideration of the production of beetroot sugar, both raw and refined, on the continent of Europe, stimulated as it is alleged by bounties. How striking had been the progress of the beetroot industry he showed by comparing the sugar production of the world at intervals during the last quarter of a century. In the first decade the cane sugar production was increased by 266,000 tons, and the beetroot production by 640,000 tons. In the second, cane went up 668,000 tons, and beetroot 1,718,000 tons. In the last five years, up to 1897, cane had decreased 474,000 tons, and beet increased 1,415,000 tons. Among the conclusions drawn from the paper are that cane sugar can be produced cheaper than beetroot; that cane sugar can be profitably produced and sold in this country at a price materially

lower than the average price of the last fourteen years of alternate depressions and reactions; and that under free and open competition the world would cease to be dependent on the vicissitudes of the European beetroot crop.

THE issue of *Science* for March 3 contains a paper by Mr. E. D. Preston, Executive Officer to the Superintendent, on the work of the United States Coast and Geodetic Survey. The survey was first authorised in the year 1807, began serious work in 1832, and attained its present permanent status in 1843. Regular work has thus been carried on for over fifty years. Besides the ordinary trigonometrical and astronomical work, covering 350,000 square miles, the Survey has sounded and prepared charts of 164,000 square miles of sea, and has made extensive investigations into hypsometry, magnetism, gravity, and physical hydrography. The measurement of an arc of the ninety-eighth meridian is amongst the works at present in hand, and negotiations are in progress for extending the measurements of certain arcs into Mexico and Canada.

A TRANSLATION of a paper by Prof. Otto Pettersson, originally published in *Ymer*, appears in Nos. 12 and 13 of the current volume of *Die Natur*. An excellent summary is given of the aims and methods of the investigations carried on in the Baltic, the North Sea, and the North Atlantic, by Prof. Pettersson and his colleagues during the last six years, and the application of the results to meteorology, and to the study of fishery questions, is described. The paper is important in view of the proposals for further international co-operation at present under consideration, as it enters more into technical details than was possible in Prof. Pettersson's recent article in the *Nineteenth Century*.

"THE mechanics of the centrifugal machine" is treated very simply by Mr. C. A. Matthey in a paper in the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland. The author, after referring to the great loss of power due to uneven balancing in separators revolving in fixed bearings, points out the superiority of the Weston machine, in which the separator is suspended from above, and its axis kept within limits by india-rubber buffers. The stability of the arrangement is rightly attributed by the author to the imperfect elasticity of the rubber buffers, which by diminishing the precessional motion tends to bring the axis of rotation towards the vertical.

MR. JOSEPH MANNING has written a paper, published by Messrs. Swan Sonnenschein and Co., Ltd., on "The future of the metric and imperial systems of weights, measures and coinage." In it the author advocates a new system of units identical with the metric units but under different nomenclature, and a system of decimal coinage, according to which 1000 farthings would go to the pound. With regard to the former, we fail to see any advantage in using the new names "chor" and "grav" to denote units already known as the "stere" and "tonne," while it hardly seems desirable to use the name "ar" to represent the hundredth part of the metric "are." As further proof of the growth of popular interest in the metric units, we notice that *Science Gossip* for April has lent its pages to a description of the system, contributed by Mr. James Quick.

AT a recent meeting of the Society of Arts, an instructive paper was contributed by Sir Marcus Samuel on liquid fuel, in which an interesting account is given of the difficulties met with in the first attempts made to popularise the use of oil as a fuel. When the oil fields of Dutch Borneo were first opened up, the oil was not allowed to be carried in bulk through the Suez Canal, and there was not a single port in which obstacles were not placed in the way of its introduction. Now vessels carrying 6500 tons, and capable of discharging over 500 tons of oil per hour, pass through the canal regularly, and at ports such as Bombay great facilities are now given for the rapid discharge and distribution of oil cargoes, experience having demonstrated its perfect safety. The advantages claimed for high-flash oil as against coal are convenience of storage, safety, reduction of labour in stoking, and rapidity of discharge. Owing to the regularity with which it can be fed into the furnace, the alternate contraction and expansion of the fire bars and steam tubes, unavoidable when coal is used as fuel, and to which so many boiler accidents can be traced, is altogether stopped, although perhaps the risk of over-heating may be set off against this. Oil fuel is in actual use on the Great Eastern Railway, on railways in the south of Russia, in Paris, Southern California, and in South Africa; it has also been partially adopted in the Russian, German, and Italian navies. The only obstacle to its more general use is the doubt that exists as to whether the price would remain at its present level if the demand were greatly increased.

IN the *Communications* from the Physical Laboratory of the University of Leiden, No. 45, Dr. J. Verschaffelt describes measurements on the system of isothermal lines near the plait-point, and especially on the process of retrograde condensation of a mixture of carbonic acid and hydrogen. The paper is illustrated by two large diagrams representing the isothermals and condensation lines respectively.

MESSRS. TAYLOR, TAYLOR, AND HOBSON have just issued a new catalogue of photographic lenses, containing several noteworthy features. An instructive paper on "The Principles of a Lens Action" is included, and a new form of tables of conjugate foci has been added. In addition to particulars concerning the Cooke portrait lenses, the catalogue now includes the smaller Cooke lenses. A new and neat focussing mount is described, and also the Cooke extension lenses. The catalogue will interest all photographers who see it.

A PAMPHLET on "Ventilation," containing extracts from a paper on "Hospital Construction," recently read by Dr. John W. Hayward before the Liverpool Architectural Society, has been reprinted from the *Builders' Journal and Architectural Record*. The subject is an important one; and the method of ventilation and warming described by Dr. Hayward appears to meet all reasonable requirements.

"THE International Geography," upon which Dr. H. R. Mill has been engaged during the past two years, will shortly be published by Mr. George Newnes. The work is truly international in character, no less than seventy distinguished home and foreign geographers having contributed to it. Each contributor has intimate knowledge of the part of the world with which he deals, and great care has been taken to secure uniformity of plan and method; so that the work will be a concise encyclopædia of geography, suitable alike for reference or as a book for students. Among the authors we notice the names of Dr. D. Aitoff, Prof. Grenville A. J. Cole, Sir W. Martin Conway, Prof. W. M. Davis, Dr. A. M. W. Downing, Prof. Th. Fischer, Dr. H. O. Forbes, Dr. J. W. Gregory, Prof. A. Heilprin, Sir H. H. Johnston, Dr. Scott Keltie, Prof. A. Kirchhoff, Prof. A. de Lapparent, Sir William Macgregor, Sir Clements Markham, Sir John Murray, Dr. Nansen, Prof. A. Penck, Count Pfeil, the late Sir Lambert Playfair, Prof. L. Raveneau, Sir G. S. Robertson, Dr. Th. Thoroddsen, Sir C. W. Wilson, and many others well known in the scientific world. Judging from the strong and representative list of contributors, the forthcoming work will be a very valuable addition to the literature of geography.

IN two papers recently presented to the American Academy, Prof. Richards, in collaboration with Dr. Cushman and Mr. Baxter, returns to the question of the atomic weights of

nickel and cobalt. Both papers bear the stamp of highly accurate and searching work, and, in addition to a discussion of the main question, contain many subsidiary features of interest. Complete analyses of nickelous bromide and cobaltous bromide were undertaken, the salts being reduced by moist hydrogen, and the metals weighed as such. The bromine was determined as silver bromide. The final result for nickel was 58·706, and for cobalt 58·995. As the result of a critical examination of earlier determinations in the case of nickel, the authors select as the most trustworthy the numbers of Zimmermann, 58·694, and of Winkler, corrected by them to 58·69, so that the value 58·70 may be taken as final. As the authors' results for cobalt show less concordance than those for nickel, the extreme values being 58·955 and 59·021, fresh experiments involving different methods are being undertaken. The evidence of all the work is said to strongly support "Winkler's contention that nickel and cobalt, as we knew them of old, cannot contain more than an infinitesimal amount of any unknown element." Several radically different methods of preparation and many fractionations led to atomic weights, constant within a reasonable limit of experimental error. Cobalt has a higher atomic weight than nickel, although this conflicts with the inference to be drawn from the position of rhodium and palladium in the periodic classification. Amongst the minor matters involved in the above investigations the following may be mentioned :—Nickelous bromide and cobaltous bromide, when sublimed in porcelain tubes, are slightly contaminated with sodium bromide. The bromides are more easily reduced by moist than by dry hydrogen ; the metals so prepared do not occlude an appreciable amount of hydrogen, possibly on account of the trace of sodium bromide present. Both nickel and cobalt are acted upon appreciably by water, giving colloidal solutions of the hydrates. This circumstance and also the use of glass apparatus, leading to siliceous residues, account mainly for Krüss's supposed discovery of "gnomium." The colloidal solution of cobaltous oxide absorbs oxygen from the air, and deposits cobaltic hydrate ; no such action was observed in the case of nickel.

THE additions to the Zoological Society's Gardens during the past week include a Common Badger (*Meles taxus*), British, presented by Mr. Geo. M. Margon-Wilson ; a Silver-backed Fox (*Canis chama*) from South Africa, presented by Mr. C. R. Rennie ; two Black Rats (*Mus rattus*, var.), British, presented by Mr. W. J. Smith ; a Purple-faced Monkey (*Semnopithecus cephalopterus*, ♀) from Ceylon ; a Common Camel (*Camelus dromedarius*, ♂) from Arabia, deposited ; two Black-headed Buntings (*Emberiza melanocephala*), a Puffin (*Fratercula arctica*), European ; two Canada Geese (*Bernicla canadensis*) from North America ; fourteen Golden Carp (*Carassius auratus*) from China, purchased.

OUR ASTRONOMICAL COLUMN.

TUTTLE'S COMET (1899 *b*).—The following positions are given by Herr J. Rahts in *Ast. Nach.* (Bd. 149, No. 3555) :—

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″	Br.
April 20	4 8 26·6	+16 37 42	1·80
21	11 58·1	16 11 14	
22	15 28·9	15 44 31	1·82
23	18 59·0	15 17 34	
24	22 28·5	14 50 24	
25	25 57·4	14 23 1	
26	29 25·7	13 55 24	1·86
27	4 32 53·4	+13 27 35	

The comet should be looked for immediately after sunset ; it travels during the week from between γ and δ Tauri to a position about 2° south of α Tauri (Aldebaran).

TEMPEL'S COMET (1873 II.).—M. L. Schulhof, of the Paris Observatory, gives, in a communication to *Ast. Nach.* (Bd. 149, No. 3554) the calculated elements and ephemeris of this comet, which will arrive at perihelion about the middle of June next.

Elements.

T = 1899, June 18 0 Paris Mean Time.

$$\begin{aligned} M &= 352^\circ\ 26'\ 22''\cdot 9 \\ \pi &= 306\ 33\ 51\cdot 5 \\ \Omega &= 120\ 57\ 57\cdot 0 \\ i &= 12\ 38\ 56\cdot 2 \\ \phi &= 32\ 49\ 41\cdot 2 \\ \mu &= 671''\cdot 8846 \\ \log a &= 0\cdot 481808 \end{aligned} \quad \left.\begin{matrix}\pi\\ \Omega\\ i\end{matrix}\right\} 1899\cdot 0$$

Ephemeris for 12h. Paris Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″	Br.
April 20	18 24 29·3	−5 36 9	0·285
21	26 16·0	5 31 27	
22	28 2·4	5 36 44	0·317
23	29 48·5	5 32 2	
24	31 34·4	5 27 20	
25	33 20·0	5 22 39	
26	35 5·4	5 18 0	0·358
27	18 36 50·4	−5 13 22	

The brightness in 1878 was 0·113, while during the apparition of 1894 it was 0·190, so that the present return should be much easier of observation. The comet will be travelling from the south-eastern border of Ophiuchus, through Scutum Sobieski, into Aquila, and search should be made in the early morning.

VARIABLE STAR NOTES.—The fourth pamphlet issued from the Rousdon Observatory of Sir C. E. Peek, at Lyme Regis, South Devon, contains the individual observations of the variables R and χ Cygni, extending over the period 1887 January 20 to 1896 December 23. The resulting estimates of magnitude are also plotted out at the end of the pamphlet showing the light-curves, from an examination of which it appears that the period of χ Cygni is something over 14 months, and that of R Cygni about 12·5 months.

SPECTRUM OF SATURN'S RINGS.—Prof. Vogel many years ago stated that he had observed a strong absorption band in the red region of the spectrum of Saturn, at λ 6183, which was extremely faint or absent in the spectrum of the rings. Prof. Keeler in 1889 could detect no trace of it in the ring spectrum, using the 36-inch Lick refractor. During the evening of August 18, 1898, Mr. Ellerman, of the Yerkes Observatory, photographed the spectrum of Saturn on an isochromatic plate very sensitive to the red region, using the 40-inch telescope. The spectroscope used had one flint prism of 60° angle, the collimator and camera lenses being 1·4 inches aperture and 19 inches and 10½ inches focus respectively. The planet being far south the exposure had to be short, so the slit had to be used fairly wide. A reproduction of an enlargement (7·5 times) from this negative is given in *Astrophysical Journal* for March (vol. ix. p. 186). The absorption band referred to is very readily seen in the spectrum of the ball of the planet, but no trace of it is at all visible in the ring spectra. The conclusion drawn by Prof. Hale from this fact is that the rings possess little or no atmosphere, thus confirming the result formerly obtained from visual observations.

THE SUN'S MEAN TEMPERATURE.—In our last issue we called attention to a criticism of Dr. See's article on "The Sun's Heat," by Dr. A. S. Chessin, in the *Astronomical Journal*, No. 456. In the current issue, No. 458, there are some further remarks by Prof. S. Newcomb and Dr. Chessin, which we give below.

Prof. Newcomb writes : "Dr. Chessin's remark in *A. J.*, 456, does not seem to me well founded. The problem is this : The parts of a spherical gaseous mass A are kept in equilibrium between the force of their mutual gravitation, and of their elasticity due to temperature. To preserve this equilibrium let there be an absolute temperature T_0, which may increase from the surface to the centre. Now, by the radiation of heat, let the radius of the mass A contract from R_0 to R. What is the temperature T necessary to maintain the equilibrium of the mass after contraction ? The formula given by See,

$$T = \frac{R_0 T_0}{R},$$

does not seem open to doubt. I do not see how hydrodynamic laws enter into the question."

Dr. Chessin writes: "With regard to Prof. Newcomb's remark, I beg to observe that I did not raise the question as to whether the law which Dr. See calls *his* (and which, more correctly, should be called Ritter's, who expressed it in 1881, as Dr. See states himself), was at all plausible or not. I simply objected to Dr. See's *derivation*, in the course of which, as I have stated before, he assumes that which he wants to prove.

"As to neglecting the principles of hydrodynamics, it suffices to point out, for example, the inadmissible assumption of uniform density throughout a gaseous body in dynamical condition (v.l. contraction and radiation)."

SOURCES OF IMPORTANT MINERALS.

A VALUABLE Blue Book by Prof. C. Le Neve Foster, F.R.S., containing statistics relating to persons employed in mining, the output of minerals, and the number of accidents occurring in mines and quarries in the British Colonies and in foreign countries, has just been published by the Home Office. The tables are not complete, but the information given in them presents many points of interest. The part of the introduction referring to output is printed below, and the two accompanying diagrams, reproduced from plates in Prof. Foster's report, illustrate graphically the variations in the production of coal and iron ore in several countries during the past twenty years.

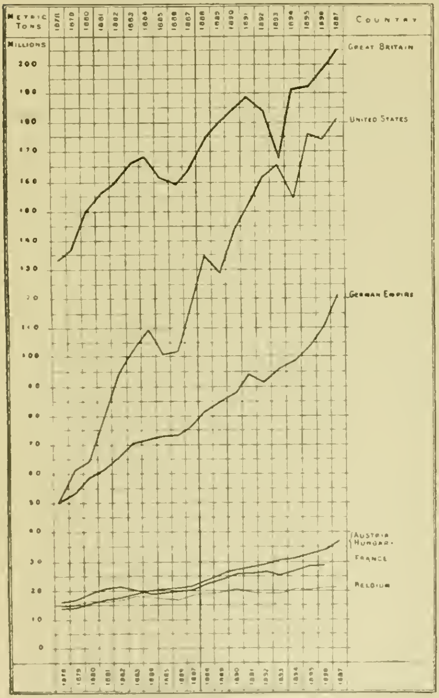


FIG. 1.—Diagram showing the output of coal in six the principal coal-producing countries during the past twenty years.

Coal.—The United Kingdom is at present the most important producer of coal, but the rapid growth of coal mining in various parts of the United States, as apparent from the curve in diagram (Fig. 1), and the knowledge of its enormous resources, lead to the belief that the mother country will eventually have to yield its position to the younger branch of the Anglo-Saxon race. The British Empire, as a whole, produces more than two-fifths of all the coal raised in the world.

Copper.—Figures do not furnish a proper basis for comparison of output, because some countries state their output as ore, and others as metallic copper. The United States, with the enormous output of 223,000 tons of metal, produce more than half the copper of the world, and Spain and Portugal together about one-eighth.

Gold.—In the race of the gold-producing countries the South African Republic has been rapidly gaining upon the United States, and, though a little behind in 1897, will take the first place for the current year. In 1897 it may be said approximately that these two countries and Australasia each produced more than one-fifth of the world's supply. The only other country needing mention is Russia, with nearly one-tenth of the total.

Iron.—Tables which merely show tons of ore without stating the average percentages of metal must be read with caution; but, whether judged by the gross weight of the ore or by the actual amount of metal present, the United States take the lead among the iron-yielding countries. Great Britain comes next as a producer of iron, and is followed by Germany with its 10

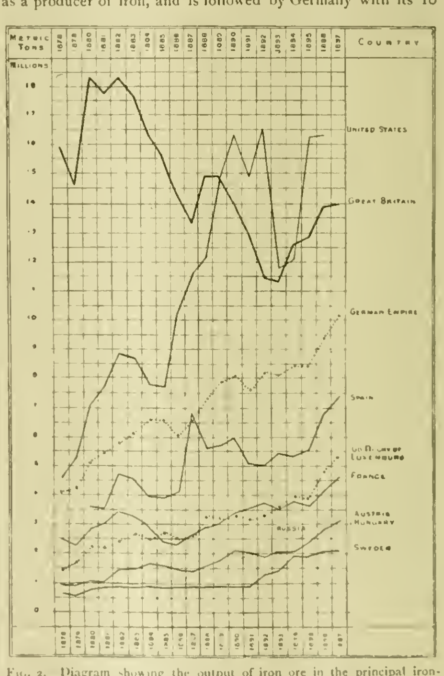


FIG. 2. Diagram showing the output of iron ore in the principal iron-producing countries during the past twenty years.

million tons of ore derived mainly from the poorer but easily wrought deposits of Alsace-Lorraine. Spain ranks fourth with a production of 7 million tons of ore; but in comparing its position with that of Germany, the higher percentage of metal in the Spanish ores should be borne in mind. In the same way the low percentage of iron in the ore produced in Luxemburg must be considered in comparing its output of 5 million tons with that of France, Russia and Austria-Hungary.

The production of iron ores in the principal countries during the past twenty years is illustrated by a diagram (Fig. 2).

Lead.—Spain is the greatest lead-producing country in the world; it is followed at no great distance by the United States. Germany produces little more than half the total output of Spain.

Petroleum.—Russia and the United States are the two great petroleum producers. In the British Empire, Canada and Burma are the only oil regions deserving mention at the present time, though their output is, comparatively speaking, small.

Salt.—The United States and the United Kingdom produce about 2 million tons of salt each, Russia $1\frac{1}{2}$ million, Germany $1\frac{1}{4}$ million, India about 1 million.

Silver.—Here again the United States are the largest producers, followed closely by Mexico. Australasia furnishes an output nearly equal to one-third of that of the United States, and Bolivia and Germany approximately the same amount.

Tin.—The Malay Peninsula is *facile princeps* as regards the production of tin, probably yielding nearly two-thirds of the world's supply; and when aided by other British Possessions fully three-quarters.

Zinc.—The mines of Upper Silicia alone would suffice to make the German Empire *par excellence* the zinc-producing country of the whole world. The United States, after a long interval, take the second place in the list.

It must be carefully remembered that many valuable minerals are not mentioned: for instance, Cape Colony produces diamonds to the value of $4\frac{1}{2}$ millions yearly; Italy has no equal for its sulphur, Chili for its nitrate of soda, Germany for its potassium salts, Spain for its quicksilver, and the United States for their phosphates.

ON THE ORIGIN OF MAGNETO-OPTIC ROTATION.[1]

IT is known (*Phil. Mag.*, December 1897) that when in a material molecule there exists an independently vibrating group of ions or electrons, for all of which the ratio e/m of electric charge to inertia is the same, then the influence of a magnetic field H on the motions of this group is precisely the same as that of a rotation with angular velocity ω, equal to $\frac{1}{2}eH/mc^2$, imposed on the group around the axis of the field, on the hypothesis that the extraneous forces acting on the ions are symmetrical with respect to this axis. This result involves the main features of the Zeeman effect; it requires that the separations of the doublets representing the spectral lines arising from such a group must all be equal when measured in differences of frequency, or be inversely as the square of the wave-length in vacuum when measured in differences of wave-length, a relation which Preston has recently found to obtain for the natural series of lines in ordinary spectra.

The object of this note is to point out that it is possible to deduce the Faraday effect from the Zeeman effect by general reasoning, as regards any medium in which the optical dispersion is mainly controlled by a series of absorption bands for which the Zeeman effect obeys the above law, without its being necessary to introduce any special dynamical hypothesis. For this law ensures that the effect of the magnetic field on the periods of the corresponding free vibrations of the molecules is the same as that of a bodily rotation, say with angular velocity ω, round its axis;[2] while the complete circular polarisations of the Zeeman doublets, viewed in the direction of the axis, show that their states of vibration are symmetrical with respect to that axis. Thus, Ω being the angular velocity of the displacement vector in a train of circularly polarised waves traversing the medium along the axis, the state of synchronous vibration which it excites in the molecules will have exactly the same formal relation to this train when the magnetic field is off as it would have to a train with very slightly different angular velocity $\Omega \pm \omega$ when the magnetic field is on, the sign being different according as the train is right-handed or left-handed. Now, change of this angular velocity Ω means change of period of the light: thus the propagation of a circularly polarised wave-train when the field is on is identical with that of the same wave-train when the period is altered by its being carried round with angular velocity $\pm\omega$ and there is no influencing magnetic field.

This last result has been employed by H. Becquerel as a single hypothesis (suggested by Maxwell's notion of a magnetic field in this connection as a vortex in the medium) from which to deduce quantitatively both the Zeeman effect and the Faraday effect, and thus correlate them ("Sur une interprétation applicable au phénomène de Faraday et au phénomène et Zeeman"—*Comptes rendus*, November 8, 1897). He shows, employing chiefly the quantitative results of his own previous experimental investigations, that the hypothesis is capable of providing a satisfactory general view of the whole range of the phenomena, and in particular that it leads immediately to a simple law of dispersion for the Faraday effect, namely rotatory power proportional to $\lambda dn/d\lambda$ where n is the refractive index corresponding to wave-length λ measured in vacuum, a law which is in good agreement with Verdet's results for carbon disulphide and creosote.

The preceding argument provides a general dynamical justification of this hypothesis, for the case of all media in which the ordinary gradient of dispersion is mainly controlled by one or more powerful absorption bands beyond the visible spectrum, for all of which the Zeeman constants are the same: it also shows that Becquerel's hypothesis has an approximate validity when these constants are nearly the same for all the effective bands. In the immediate neighbourhood of any single band the dispersion is anomalous, and is controlled practically by that band alone; the application will then be exact, and in Becquerel's hands it has given a complete account of the excessive and anomalous rotation first observed by Macaluso and Corbino in sodium vapour for light adjacent to the D lines. As was to be anticipated, these simple general conclusions are consistent with the results of the more special dynamical investigations of FitzGerald and Voigt.

[1] Communication to the Cambridge Philosophical Society, March 6, by J. Larmor, F.R.S.

[2] The circumstance that the mean of the two disturbed periods is equal to that of the undisturbed line shows that no effect of constitutive type is involved in addition.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR ROBERT MUIR, at present professor of pathology in the University of St. Andrews, has been appointed to the chair of Pathology in the University of Glasgow.

BY the will of the late Miss Elizabeth Brown, who died on March 5, the British Astronomical Association will receive her observatory at Further Burton, with the astronomical instruments in it, and the sum of 1000*l*.

Science states that Mr. John D. Rockefeller has offered 100,000 dollars to Denison University, Granville, O., if the friends of the institution will, within the next year, raise the sum of 150,000 dollars.

THE British Child-Study Association has issued the first number of a magazine entitled *The Paidologist*, which is to be published three times a year, and will be concerned with the physical and psychical aspects of child-life. The aims of the Association are both scientific and educational; and the new magazine is intended as a medium in which the results of research on child psychology shall be recorded, and practical suggestions which will assist in the evolutionary progress of the race shall be described.

WITH reference to the Board of Education Bill, the Council of the Association of Technical Institutions has unanimously adopted the following resolutions: (1) In reference to Section 2 of Clause 3, "That, inasmuch as in some counties and in most county boroughs the funds available are already fully appropriated for the purposes of technical education it is not, in the opinion of this Council, desirable that these funds should be applied to the payment of the expenses of inspecting schools under this Section." (2) "That, in the opinion of this Council, having regard to the fact that the funds assigned under the provisions of the Technical Instruction Acts are not more than adequate for the maintenance and development of technical education, it is essential that for the further purposes of secondary education additional funds be provided." It has also decided to take steps to endeavour to secure that the interests of technical education shall be adequately represented on the consultative committee named in Clause 4 of the Bill.

THE Commissioners appointed under the University of London Act, 1898, have given notice that they are now prepared to consider applications from duly qualified teachers and lecturers giving instruction of the University type in public educational institutions situate within a radius of thirty miles from the University buildings, who desire to be recognised as teachers of the University. By a "public educational institu-

tion" the Commissioners understand to be meant an institution for general education or for any special kind of education, which is not carried on for private gain or profit. Applications stating the applicants' qualifications should be addressed to the Secretary, Mr. T. Bailey Saunders, at the office of the Commission, 32 Abingdon Street, Westminster, S.W., on or before Saturday, May 13, 1899. It will, it is added, be convenient if teachers and lecturers in physics, chemistry, or other subjects, effective instruction in which requires laboratories and expensive apparatus, would state what resources of that character they have at their disposal. Teachers or lecturers on whose behalf applications have already been made by their colleges or schools need not repeat them.

At a meeting held in University College, Bristol, on Thursday last, the Bishop of Hereford, President of the College, being in the chair, it was decided to found a University College Colston Society, holding an annual dinner in the same manner as the Grateful Dolphin, and Anchor Societies, but with a distinctly educational aim. It was pointed out by the Bishop of Bristol that not only were the Colston benefactions to education larger than to all other objects combined, but that the sums devoted to this object in Bristol by Edward Colston were larger than those which have given origin to the existing annuities and doies. It is hoped that a Colston endowment fund may thus be raised, and scholarships instituted to enable girls and boys who have shown promise to pass on to the College from schools and other institutions in the city. The University College has recently fallen heir to a legacy of 5000*l*. bequeathed by the late Mr. Stuckey Lean. This will probably be devoted to a much-needed extension of buildings. Both the Bishop of Hereford and the Bishop of Bristol expressed opinions favourable to the establishment in the near future of that University for the West of England, centred in Bristol, which Sir Norman Lockyer foreshadowed when the British Association recently met in that city. We cannot but believe that the citizens of Bristol will speedily follow the lead set them by the citizens of Birmingham, and take active steps to enable those who have the cause of higher education in the West of England at heart to realise the ideal thus placed before them.

On Saturday last, in opening a new county school established at Presteign under the Welsh Intermediate Education Act, the Duke of Devonshire referred to the part he played in educational affairs. He remarked that he had on previous occasions had to protest against the assumption which seemed to have been made that he was, or professed to be in any degree, an educational expert. That was not the least the case. An educational expert should be a person who had himself received a very large and extensive education, and who had, in addition, devoted himself to the study of education, which was in itself a science and a profession. To neither of these could he lay the smallest claim. If, without the slightest pretension on his part, he had assumed to be in any sense an education advocate, it was because he had been for some considerable period deeply impressed with the national importance of the better training of the people in one branch, and that a very limited branch, of education—that was to say, in the teaching of science and of art as applied to our industries and to our commercial position. He had seen in many ways the close connection which existed between the discoveries and teaching of science and the efficiency and prosperity of our industries. He had seen how other countries appeared to be more alive to the existence of this close connection than we were ourselves, how in other countries the imparting of this kind of instruction had been made more the business of the State, and how they had been able to induce their people more fully to take advantage of the opportunities for this kind of education than we had hitherto succeeded in doing. But to see the necessity for this kind of technical training of the people, and to suggest the means by which it was to be provided, were two very different matters; and, although he had done his best to impress the views which he had formed on this subject on his fellow-countrymen, he had never professed, and he did not profess, to be an expert adviser as to the manner in which this technical training should be applied to our people.

Referring to the Board of Education Bill, the Duke of Devonshire said it had been his duty to bring in a Bill the object of which was the better organisation of education, and especially of secondary education. He thought the interests of the measure, which he believed to be an important one, might suffer if it were to be supposed that he, in the conduct of it, spoke as an educational expert with theories and ideas on education of his own, instead of being, as he was, merely a politician and an administrator charged with the duty of attempting to improve the organisation of our education with the assistance of experts who were much better qualified to advise and to give counsel than he was himself. This might be a good system or not a good system, but it was our system of government. We did not put a great strategist at the head of the War Department, or a skilful sailor, or a great shipbuilder at the head of the Admiralty. We selected ordinary statesmen or politicians to control these two great departments, requiring, as they did, the highest technical skill in the shape of skilled professional advisers. In his opinion, it would be a very great mistake indeed if we were to commit the charge of the Education Department to a professor, a schoolmaster, or an educational expert, however great might be the range of his studies, and however much he might have devoted himself to the study of the science of education.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 2.—Propagation of electrodynamic waves along a wire, by A. Sommerfeld. To approximate to practical conditions, the author admits a finite thickness for the wire, and supposes it to be single, straight, and infinite. He shows that when the frequency is high and the wire thick, propagation takes place with nearly the velocity of light; but when that is not the case, the rate may be only three-quarters of that. All the occurrences are confined to a surface layer of the wire not more than 0·1 mm. thick.—Polarisation and hysteresis in dielectric media, by W. Schaufelberger. The loss of energy by hysteresis in a paraffin ellipsoid oscillating in an electrostatic field is proportional to the square of the electric force. Ebonite is, in comparison, a very imperfect dielectric.—Proportionality of emission and absorption, by W. Voigt. The author attempts to provide a theoretical foundation for Kirchhoff's law. He is obliged to assume the coexistence of irregular and heterogeneous waves, since regular wave-trains would not obey the law.—Canal rays, by A. Wehnelt. A mica cross introduced into the dark kathode space casts a shadow upon the kathode itself, thus proving that rays proceed from the anode to the kathode. Further, it is extremely probable that no kathode rays are given out except where anode rays impinge upon the kathode. When they penetrate the kathode, we have Goldstein's "canal rays."—A new method of detecting electric waves, by A. Neugschwender. A slit is cut in the silver surface of a mirror, and the latter is placed in circuit with a cell and galvanometer. No current is indicated until the mirror is breathed upon. But the deflection that is then shown is immediately annulled by the impact of electric waves upon the mirror. Conductivity is restored when the waves cease, provided there is a source of moisture, say a wet sponge, near the galvanometer.—Isolation of long heat rays by quartz prisms, by H. Rubens and E. Aschkinass. The extremely long heat rays obtained by successive reflections at surfaces of rocksalt and sylvine are transmitted by quartz, and their refractive index is thus easily determined. It is extremely high, being 2·19 for waves 56 μ long.—Continuity of the electric discharge in rarefied air, by Mr. Cantor. The author employs the coherer to test the continuity of the vacuum discharge under conditions where Hertz pronounced them to be absolutely continuous. In every case waves were given out by the tubes. But it is still possible that part of the discharge may have been continuous.

SOCIETIES AND ACADEMIES.

London.

Entomological Society, April 5.—Mr. G. H. Verrall, President, in the chair. Mr. Blandford exhibited insects of different orders collected by Dr. Albert L. Bennett in West Africa, and read some notes by Dr. Bennett on the habits of the Goliath beetles. Mr McLachlan exhibited young larvæ of a "locust," received from Mr. E. A. Floyer, Director-General of Telegraphy in Egypt, and said by him to have caused the *Calotropis* trees in Nubia to be in a moribund condition. The

larvæ were identified by Mr. Burr as those of a species of *Poecilocerus*, probably *P. vittatus*, Klug.—Mr. Blandford gave an account of a paper by Dr. A. Ribaga, published in the "Rivista di Patologia Vegetale," v. p. 343, on an asymmetrical structure occurring in the adult female of the common bed-bug, and apparently hitherto overlooked, although it communicated with the exterior by a conspicuous notch in the fourth abdominal segment, midway between the median line and the lateral margin. This structure consisted of a large quasi-glandular mass of unknown nature in which was encapsuled an organ consisting of fibres, the free ends of which terminated in minute chitinous spines in a recess lying under the fourth abdominal segment. The adjacent margin of the fifth segment was thickened and set with strong teeth. The non-glandular part of this singular structure was conjectured by its discoverer to be a stridulating organ; but no evidence of stridulation had been obtained. It was certainly far more complex than most, if not all, other stridulating organs known to exist in insects.—Mr. G. J. Arrow communicated "Notes on the Rutelid genera *Anomala*, *Mimela*, *Popillia*, and *Strigoderma*."

Mathematical Society, April 13.—Lieut.-Colonel Cunningham, R.E., Vice-President, in the chair.—The chairman briefly referred to the loss the Society had sustained by the recent death of its foreign member, Prof. Sophus Lie.—Mr. A. B. Kempe, F.R.S., having taken the chair, Lieut.-Colonel Cunningham read a paper on conformal division. Major MacMahon, F.R.S., Messrs. Lawrence, Western, and the chairman joined in a discussion on the paper.—The following papers were communicated in abstract. On the characteristic invariants of an asymmetric optical system, Mr. T. J. Bromwich. The reduced path from one point to another is expressed in terms of the directions of the ray at those points. It is now found possible to put down eight invariants by inspection (only six are independent). These are expressed in terms of those given by Prof. Sampson (*Proceedings*, vol. xxix.). The remainder of the note consists in bringing the reduced path to two canonical forms and some geometrical interpretations.—Concerning the four known simple linear groups of order 25920, with an introduction to the hyper-Abelian linear groups, Dr. L. E. Dickson. (1) On the direct determination of stress in an elastic solid with application to the theory of plates; (2) on the stress in a rotating lamina; (3) the uniform torsion and flexure of incomplete tores with application to helical springs, Prof. J. H. Michell.—The theorem of residuation, Noether's theorem, and the Riemann-Roch theorem, Dr. F. S. Macaulay.—Impromptu communications were made by Messrs. Hargreaves, Heppel, Roseveare, Western, and the chairman. This last drew attention to the following curious properties of the number 7, viz.:—

$$18^3 \equiv +1, \quad 19^3 \equiv -1 \text{ (mod. } 7^2 \text{ and } 7^3)$$
$$1353^3 \equiv +1, \quad 1354^3 \equiv -1 \text{ (mod. } 7^4 \text{ and } 7^5)$$
$$82681^3 \equiv +1, \quad 82682^3 \equiv -1 \text{ (mod. } 7^6 \text{ and } 7^7)$$

but these properties do not extend to 7^8 and 7^9.

EDINBURGH.

Royal Society, April 3.—Prof. Duns in the chair.—Dr. R. Kennedy read a paper on the restoration of coordinated movements after nerve section, of which the following are some of the main results. The peripheral segment of the divided sciatic nerve was rotated to the extent of a semicircle before reunion to the central segment by means of suture. As a result of this, the nerve fibres of the central segment were brought into apposition with non-corresponding peripheral segments, and the nerve thus placed in the best conditions for the formation of new paths for the nervous impulses. Restoration of coordinated movements commenced on the seventh day after the operation, and was complete from the fourteenth to the twenty-first day. Despite this early restoration of function, the peripheral segment showed the presence of Wallerian degeneration and of complete regeneration of young nerve fibres, showing that early restoration of function was not due to healing by so-called first intention, but, instead, to regeneration of the peripheral segment. In one case in which the two segments of the divided sciatic were united accurately in the old relationship, an exactly parallel course as regards the time taken for restoration of function was exhibited.—A paper was also communicated by Mr. Bellyse Baildon, at present lecturer in English in the University of Vienna, on the rimes in the authentic poems of William Dunbar.

PARIS.

Academy of Sciences, April 10.—M. van Tieghem in the chair.—On the interpretation of a limited number of observations, by M. Hatt. The author discusses the method of dealing with a measurement which deviates considerably from the others when the total number of observations is small, recently proposed by M. Vallier, and shows by means of a particular case that the treatment suggested is not always trustworthy.—On the applications of aluminium, by M. Henri Moissan. A criticism of the recent work of M. Ditte on this subject. M. Moissan points out that the aluminium used by M. Ditte in his researches was not rigorously analysed, and that he attached no importance to the small impurities of the metal, although these latter may well have had a considerable influence upon the results. Aluminium is now produced in a much purer state than was the case five years ago, a series of seven analyses, made in 1893, giving a mean percentage of 93·4, as against 97·8 per cent. for aluminium made four years later. The fact that the aluminium water vessels used in Madagascar were mounted in contact with iron, may also have influenced the rapidity of corrosion by the electrolytic action which would be set up at the expense of the aluminium.—The production of electromotive forces by the displacement of masses of liquid of different conductivities submitted to the magnetic action, by M. R. Blondlot. If a vessel containing two layers of zinc sulphate of different concentrations, into each of which is plunged an electrode of amalgamated zinc, is placed in a strong magnetic field, when the liquids are mixed, differences of electromotive force can be observed between the two electrodes by means of a capillary electrometer. The theory of the results is fully discussed.—The favourable action exercised by the pancreas on alcoholic fermentation, by MM. R. Lépine and Martz.—Application of the *criterium of Tisserand* to the small planets, by M. Jean Mascart.—On a differential linear equation, by M. A. Liapounoff. A discussion of the equation

$$\frac{d^2y}{dx^2} + \mu p(x)y = 0,$$

where $p(x)$ is a given continuous function of a real variable x, having a period ω, and μ an arbitrary parameter.—A new interpretation of the condition necessary for a double integral, taken over a surface, to be independent of the boundary of the surface, by M. Ch. Méray.—On the homography of the theory of beams, by M. Andrade.—On surfaces of plain or spherical lines of curvature, by M. Émile Waelsch.—Three formulæ of great generality relating to curves in space, by M. N. I. Hatzidakis.—On the effect of an increase or decrease of pressure upon the electrolytic interrupter, by M. A. Le Roy. Both a decrease and an increase of the atmospheric pressure interferes with the working of the Wehnelt interrupter.—Some working conditions of the Wehnelt electrolytic interrupter, by M. Paul Bary.—On the variation of the electrical resistance of metals and their alloys, due to torsion, by M. Coloman de Szily. To eliminate the effects of temperature, the alloy constantin was chosen, the coefficient of increase of resistance with temperature of which is extremely small, and the work carried out in a room the temperature of which did not vary 0°·1 C. during the experiments. The resistance was found to increase with the angle of torsion; up to the elastic limit of the material these two quantities were proportional, but for higher angles of torsion the resistance increased more rapidly than this.—Points correlative to the points of Bravais, by M. Pierre Lefebvre.—On a new method of preparing the silicide of iron, FeSi, by M. P. Lebeau. A mixture of iron filings and silicide of copper, the latter being in excess, is heated in the electric furnace. The resulting ingot consists of a mass of crystals of iron silicide, cemented together by silicide of copper, the latter being readily removed by dilute nitric acid.—The preparation and properties of a crystallised sub-phosphate of copper, by M. Georges Maronneau. Copper phosphate and carbon heated together in suitable proportions in the electric furnace, give a crystallised compound of copper and phosphorus of the composition Cu_2P.—On the thermal properties of lime prepared at different temperatures, by M. Henri Gautier. Limes prepared at different temperatures show remarkable differences in the rate of hydration when placed in water, lime fused in the electric furnace being so slowly acted upon that it is possible to accurately determine its density in water. It was thought that these differences might be due to differences in the molecular state of the

lime, which would correspond to variations in the heats of solution. This, however, was not borne out by the experiments, samples of lime prepared at 1000°, 1200°, 2000°, and the temperature of the electric furnace all giving the same results in the calorimeter.—Actino-photometer based upon the luminosity of phosphorescent zinc sulphide and the intensity or nature of the exciting sources of light, by M. Charles Henry.—On dextrine considered as a reserve material, by M. Leclerc du Sablon.—On some new anatomical peculiarities in the fatty grains (cotyledons and endosperm), by M. Edouard Heckel.—On an extraordinary halo observed at Paris, April 5, 1899, by M. Joseph Jaubert.

DIARY OF SOCIETIES.

THURSDAY, APRIL 20.

ROYAL SOCIETY, at 4.30.—The Physiological Action of Choline and Neurine: Dr. Mott, F.R.S., and Dr. Halliburton, F.R.S.—Intestinal Absorption, especially on the Absorption of Serum, Peptone, and Glucose: Prof. R. Waymouth Reid, F.R.S.—Studies on the Morphology of Spore-producing Members. No. 4. The Leptosporangiate: Prof. F. O. Bower, F.R.S.—Note on the Fertility of Different Breeds of Sheep, with Remarks on the Prevalence of Abortion and Barrenness therein: W. Heape.—Some further Remarks on Red-water or Texas Fever: A. Edington.

ROYAL INSTITUTION, at 3.—The Atmosphere: Prof. J. Dewar, F.R.S.

LINNEAN SOCIETY, at 8.—The Botany of the Ceylon Patanas: H. W. H. Pearson.—Imitation as a Source of Anomalies: Prof. R. J. Anderson.—List of British and Irish Spiders.—Rev. O. Pickard Cambridge, F.R.S.

CHEMICAL SOCIETY, at 8.—Some Dipyridyl Derivatives from Citrazinic Acid: W. J. Sell and H. Jackson.—On the Interaction of Mercurous and Mercuric Nitrites, with the Nitrites of Silver and Sodium: P. C. Ray.—The Synthesis and Preparation of Terebic and Terpenylic Acids: W. Trevor Lawrence.—The Allotropic Modifications of Phosphorus: D. L. Chapman.—β-Isopropyl Glutaric Acid: F. H. Howles and J. F. Thorpe.—Ethyl Ammoniumsulphite: Edward Divers and Masataka Ogawa.—Ethyl Ammonium Selenite and Non-existence of Amidoselenites (Selenosamates): Edward Divers and Seihachi Hada.

INSTITUTION OF CIVIL ENGINEERS, at 8.—"James Forrest" Lecture: Magnetism: Prof. J. A. Ewing, F.R.S.

FRIDAY, APRIL 21.

ROYAL INSTITUTION, at 9.—Structure of the Brain in Relation to its Functions: Frederick Walker Mott, F.R.S.

PHYSICAL SOCIETY, at 5.—On the Effect of a Solid Conducting Sphere in a Variable Magnetic Field on the Magnetic Induction at a Point Outside: C. S. Whitehead.—Demonstration of Richards's Method of Standardising Thermometers: Dr. R. A. Lehfeldt.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Relations of Bacteriology to Epidemiology: Dr. F. R. Blaxall.

SATURDAY, APRIL 22.

GEOLOGISTS' ASSOCIATION.—Excursion to Staines. Director: W. Whitaker, F.R.S. Leave Waterloo at 1.57 p.m.; arrive Staines Junction 2.36 p.m.

MONDAY, APRIL 24.

SOCIETY OF ARTS, at 8.—Leather Manufacture: Prof. Henry R. Procter.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Journeys on the Nyasa-Tanganyika Plateau: Captain F. R. F. Boileau, R.E., and L. A. Wallace.

SOCIETY OF CHEMICAL INDUSTRY, at 8.30.—The Relations of the Society to Chemical Engineering and to Industrial Research: George Beilby.

INSTITUTE OF ACTUARIES, at 5.30.—On the Requirements of the Life Assurance Companies Act, 1870, in regard to Valuation Returns, with some Notes on the Classification and Valuation of Special Policies: Ralph Todhunter.

TUESDAY, APRIL 25.

ROYAL INSTITUTION, at 3.—Zebras and Zebra Hybrids: Prof. J. Cossar Ewart, F.R.S.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Ju Ju Laws and Customs of the Niger Delta: Le Comte C. de Cardi. Illustrated by Lantern Slides and a variety of objects from West Africa.—Exhibition of Lantern Slides of Views in the Colony of Sierra Leone and the Protectorate, with Short Descriptive Account: T. J. Alldridge.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Annual General Meeting of Corporate Members.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—A Demonstration of the Making of Glass Diaphragms: Thomas Bolas.

WEDNESDAY, APRIL 26.

SOCIETY OF ARTS, at 8.—Coal Supplies: T. Forster Brown.

GEOLOGICAL SOCIETY, at 8.—On Limestone-Knolls in the Craven District of Yorkshire and elsewhere: J. E. Marr, F.R.S.—The Limestone-Knolls below Thorpe Fell, between Skipton and Grassington in Craven: J. R. Dakyns.—On Three Species of Lamellibranchs from the Carboniferous Rocks of Great Britain: Dr. Wheelton Hind.

THURSDAY, APRIL 27.

ROYAL SOCIETY, at 4.30.

ROYAL INSTITUTION, at 3.—The Atmosphere: Prof. J. Dewar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Experiments on Alternate Current Arcs by Aid of Oscillographs: W. Duddell and E. W. Marchant. (Conclusion of Discussion.)—Capacity Measurements of Long Submarine Cables: J. Elton Young.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Address by the President, Sir William H. White, K.C.B., F.R.S.

FRIDAY, APRIL 28.

ROYAL INSTITUTION, at 9.—Some Features of the Electric Induction Motor: Prof C. A. Carus Wilson.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Evaporative Condensers: Harry G. V. Oldham.

BOOKS and SERIALS RECEIVED.

BOOKS.—Elementary Physics and Chemistry, First Stage: R. A. Gregory and R. T. Simmons (Macmillan).—Th. Ipané: C. Graham (Unwin).—La Bicyclette, sa Construction et sa Forme: Dr. C. Bourlet (Paris, Gauthier-Villars).—Die Vegetation der Erde, iii.: Dr. G. Radde (Leipzig, Engelmann).—The Hunterian Oration delivered on February 14, 1899; Sir W. MacCormac (Smith, Elder).—Inwood's Tables of Interest and Mortality for the Purchasing of Estates, &c., 25th edition, revised, &c., by W. Schooling (Lockwood).—Lehrbuch der Algebra: Prof. H. Weber, Zweite Auflage, Zweiter Band (Braunschweig, Vieweg).—Geschichte der Physikalischen Experimentierkunst: Profs. Gerland and Traumüller (Leipzig, Engelmann).—The Natural Waters of Harrogate: Dr. F. W. Smith (Dawbarn).

SERIALS.—Zeitschrift für Physikalische Chemie, xxviii Band, 3 Heft (Leipzig).—National Geographic Magazine, April (Washington).—The Atoll of Funafuti, Part 7 (Sydney).—Monthly Weather Review, December, 1898, and Annual Summary for 1898 (Washington).—Knowledge, April (High Holborn).—The Photo-Miniature, April (Dawbarn).—Transactions of the Astronomical and Physical Society of Toronto for the Year 1898 (Toronto).—American Journal of Science, April (New Haven).—Popular Astronomy, April (Northfield).—Atlantic Monthly, April (Gay).—Morphologisches Jahrbuch, 27 Band, 1 Heft (Leipzig).—Agricultural Gazette of New South Wales, February (Sydney).—Mémoires de la Société de Physique, &c., de Genève, Tome xxxiii. Part 1 (Genève).

CONTENTS.

THURSDAY, APRIL 27, 1899.

A HISTORY OF PHYSICS.

A History of Physics. By Prof. Florian Cajori. Pp. viii + 322. (London: Macmillan and Co., Ltd., 1899.)

IT is a formidable undertaking to write a book on the history of physics beginning with the dawn of science and including helium and Röntgen rays, and the task does not become easier when the whole has to be condensed into the narrow limits of 300 pages. We possess a number of more extensive histories, such as Heller and Rosenberger, and a few most valuable biographies of eminent men. These are boiled down into the present volume, which is readable and generally accurate, but is too slight and superficial to serve any useful purpose. The study of the history of science is of the greatest importance to the scientific man, and in addition, it is, when properly treated, a most fascinating study; but when we come to estimate the value of any particular treatise, we must ask ourselves what it is precisely in the historical treatment that interests us. For when we wish to boil down our information we must know what has to be retained and what may be rejected, or else we should commit the error of imitating the manufacturer of meat extracts, who retains only the gelatine and water. That is, in my opinion, what Mr. Cajori has done. It may be his misfortune rather than his fault that the editor of NATURE has entrusted this review to me; but having always taken a considerable interest in historical questions, I must acknowledge the author's reading and learning while I question his judgment. That, of course, may be a matter of opinion. The value of historical studies seems to me to lie in two directions. It is of high interest to follow out the evolution of thought, the gradual development of ideas, from the first suspicion of a new truth to its final experimental proof or mathematical demonstration. The way especially in which the same idea constantly originates simultaneously in different minds, and the question how far the different view often adopted by different nations is purely a matter of education, or has some deeper cause, has never yet been fully developed.

But, quite apart from this, every reader of original papers knows how many points are always missed by subsequent writers, and how clear ideas are only obtained by a study of original sources. If, for instance, we only know Faraday, or Maxwell, or Hertz through modern text-books, however good these may be, we shall miss a large number of important suggestions. Led by these considerations, Prof. Ostwald has originated the reprinting of important treatises under the name of "Klassiker der exacten Wissenschaften," and in the announcement of this publication has regretted the neglect of historical studies.

Curiously enough, Prof. Cajori quotes this regret of Ostwald's, and expresses the hope "that the survey of the progress of physics here presented, may assist in remedying this defect so clearly pointed out by Prof. Ostwald." As a matter of fact, Ostwald's remedy for what he terms the "absence of the historical sense," lies in the reading of original memoirs, while Prof. Cajori's cure lies in the prescription of small homœopathic globules intended to contain the concentrated concoction of all that is essential; but whether this intention can be realised or not is exactly what is open to doubt. I must justify the opinion I have expressed by a few examples of Prof. Cajori's style and manner of treatment. I take in the first instance the reference to the second law of thermodynamics.

"In February 1850, Rudolph Clausius (1822–1888) communicated to the Berlin Academy a paper on the same subject, which contains the Protean second law of thermodynamics: 'Heat cannot of itself pass from a colder to a hotter body.' . . . In March 1851, there appeared a paper by Wm. Thomson, which contained a perfectly rigorous proof of the second law. He obtained it before he had seen the researches of Clausius. The statement of this law, as given by Clausius, has been much criticised, particularly by Rankine, Theodor Wand, P. G. Tait and Tolver Preston. Repeated efforts to deduce it from general mechanical principles have remained fruitless. The science of thermodynamics was developed with great success by Thomson, Clausius, and Rankine. As early as 1852, Thomson discovered the law of dissipation of energy, discovered at a later period also by Clausius."

Apart from the fact that Clausius' paper of 1850 does not either contain the words quoted, nor any reference to a second law at all (though the substance of it is given in the paper), one would like to know to whom the information given in the passage can be of any use. If a student possesses no knowledge of thermodynamics, he will not be any the wiser by it; and if he does, he must have read books, such as Maxwell's "Theory of Heat," or Baynes' "Thermodynamics," and in any of these he will find much more ample and accurate historical references than those given by Mr. Cajori. In the same way throughout the book, the author generally does not go beyond what ought to be, and often is given in the ordinary text-books. As an example how short statements, though correct, often convey incorrect ideas, I give the account of the historical evolution of the ohm:

"In 1861 the British Association and Royal Society of London appointed a committee, with Lord Kelvin at its head, to recommend a unit ('B.A.' unit). Weber's absolute unit of resistance, was a velocity. The British committee adopted this unit in principle. . . . The securing of a convenient unvariable resistance equal to 10^9 absolute units has been a difficult task. The B.A. unit was a little too small. The 'legal ohm' was provisionally adopted in 1883, by a committee appointed by the congress of 1881. It was the resistance at 0° C. of a column of mercury, 1 square millimetre in cross section and 106 centimetres long. Competent investigators, like Rayleigh and Mascart, contended that this column was a little too short, but some smaller values obtained by certain experimenters led to the adoption of the mean value of 106 centimetres. The 'legal ohm' satisfied no one, and failed to become legal in any country.

"Henry A. Rowland, after pointing out errors in some of the determinations previously made, found the length of the mercury column in question to be 106·32 centimetres."

As a matter of history, Rowland's paper of 1878, which is not mentioned, is of much greater importance than the later one, because it drew attention to the inaccuracy of the original determination of the British Association. There is no reason why Rowland's later investigation,

published jointly with Kimball in 1884, should be singled out in the above passage, while Rayleigh is patronised as a "competent investigator."

In the history of the earlier times Prof. Cajori has followed good guides, such as Whewell and Mach; and though here also the space is entirely inadequate to give a sufficient account of the subject, we like this portion better than his treatment of contemporary science.

That there should be omissions was inevitable, but it might have been thought that the kinetic theory of gases was of sufficient importance to justify a short paragraph, while the only reference to that theory is to be found in the statement that a mathematical investigation of the radiometer action was given by Clerk Maxwell. Here again, as a matter of history, it was the discussion between Osborne Reynolds and Johnstone Stoney, not alluded to in the book, which brought about the correct explanation of the radiometer, and however important Maxwell's paper may be, it only appeared when the matter was cleared up. In a detailed historical account it is often necessary to allude to scientific squabbles and unpleasant discussions, but the author of this book might well have pleaded want of space, and omitted, for instance, such a passage as this: "William Thomson and Tait, placing a much lower estimate on Mayer's researches, brought the charge that Tyndall was belittling the work of Joule." I have marked several passages which are open to criticism, but it is not my intention to find fault with the details of a book which, as a whole, is perhaps as well done as could possibly be. It is the whole attempt to collect isolated facts in the belief that these constitute a history that seems to me to be mischievous. This does not, however, exclude the fact that most readers will probably find in the book some things they did not know before, and some useful references. Arthur Schuster.

OUR SEA FISHERIES.

The Resources of the Sea, as shown in the Scientific Experiments to test the Effects of Trawling and of the Closure of certain Areas off the Scottish Shores. By W. C. McIntosh, M.D., LL.D., F.R.S., &c. Pp. xvi + 248, and Tables. (London: Clay and Sons, 1899.)

It is well known that at the time of the late Lord Dalhousie's Royal Commission on Sea-Fisheries (1883–85) Prof. McIntosh conducted, for the Commission, a series of most important trawling investigations off the coast of Scotland which formed the starting-point of a good deal of the experimental and observational work of the Fishery Board for Scotland—work which has been noticed from time to time in the columns of Nature during the last ten or twelve years. The book before us is practically devoted to the summing up of that work and the discussion of its results, and there is no one probably who has a better right to do that than Prof. McIntosh, who, by his trawling investigations in 1884, suggested the experiments of the Board, and who himself may be said to have superintended and controlled the work while acting as scientific member of the Board from 1892 to 1895—when he was succeeded by Sir John Murray. All this gives additional importance to the fact that Prof. McIntosh now declares against the policy of the Fishery Board, criticises their methods and their conclusions as published in recent annual reports, and is apparently in favour of removing all restrictions upon fishing, and of throwing the territorial waters open to trawlers and liners alike.

It is clear, then, that the book deals with debatable matters, and probably few fisheries experts will agree with the author in all his points. The work is happily named the "Resources of the Sea," as the central idea running all through it is that marine animals and plants have such extraordinary powers of reproduction as to be practically unaffected by the influence of man; while the secondary title shows that it is the trawling experiments and the results of closure of sea-areas off the coast of Scotland that are specially discussed and criticised.

There is an "Introductory" chapter, giving a general review of marine life, with most of the statements in which every biologist will agree. It may be remarked, however, that the vast possibilities of increase which may be true of diatoms and many groups of lower animals, and even of some fish, are not necessarily true of all kinds of food fishes in the inshore waters. The plaice and the sole are probably in this respect in very different case from the herring, the cod, and the oft-quoted haddock.

Prof. McIntosh next gives us a chapter dealing with the effects of trawling, and of the hooks of liners, upon the food, the eggs and the young of our fishes; the present state of the fishery steamers and their apparatus, and upon the method in which the Fishery Board for Scotland have carried out the recommendations of the Trawling Commission. In all of this there is naturally a good deal of evidence to show that the trawlers do not do the harm to the sea-bottom that has been from time to time ascribed to them; and we readily agree with the conclusion on p. 50:

"A calm survey of the situation, therefore, does not lend support to the notion that the trawl, as ordinarily employed in sea-fishing, is the only destroyer of the invertebrate animals of the bottom; and, further, experience does not demonstrate that the sea-bottom in any known region has been, by the use of such line or trawl, so seriously impoverished as to be unable to support fish-life."

Some of us are unable, however, from what we know on other coasts, to endorse the further opinion that trawling does no great damage to the young food-fishes on the bottom. Our experience in Lancashire is that grave destruction of immature flat-fish is caused by trawling in the "nurseries" along the shallow sandy shores; and that in protected areas, such as the closed ground off Blackpool, a rapid increase of the more sedentary flat-fish takes place. We fail to understand the statement[1] on p. 234, that closure is powerless to prevent such destruction.

Prof. McIntosh then takes up, one by one, the sea-areas which have been closed against trawling by the Fishery Board, and in which experimental hauls have been made from time to time by the Board's small steamer, the *Garland*. Unfortunately that vessel is too small for the work; we labour under a similar dis-

[1] "The capture of great numbers of small fishes by either trawlers or liners is a misfortune for the country, but the closure is powerless to prevent it." This requires further explanation.

advantage in Lancashire. A Fishery Board or Committee carrying on scientific and experimental work ought to have a vessel that can go to sea and stay at sea in all ordinary weathers, and that can follow the fishing fleets and work with them on equal terms. That is not possible for either the *Garland* or the *John Fell*.

Chapters are devoted to the trawling experiments in St. Andrews Bay, in the Firth of Forth, in the Moray Firth, and in the Firth of Clyde; and in each case it is argued that the closure has effected no change, that there has been no great increase in the fish population, and that, on the other hand, there has not been that decrease which the Board have recently made a reason for wishing to obtain control of the fishing on the offshore spawning grounds. But it seems pretty clear, from the detailed analysis given of the statistics, that the observations are not really sufficiently numerous and sufficiently trustworthy to justify any general conclusions. We are constantly reminded of the smallness of the steamer and the inefficiency of her trawl.[1] Prof. McIntosh himself evidently distrusts the results, and speaks more than once of the "uncertainty." The observations, moreover, were not always taken in the same months, and so certain series of the statistics cannot fairly be compared. It is curious that the results obtained from the "closed" and the "open" areas have not been treated quite separately in the tables. Surely in a discussion of the effects of closure it would have been safer to have rigidly excluded the statistics not obtained wholly from closed grounds.

Nor is it quite clear to us that Prof. McIntosh is convinced by the evidence he brings as to the abundance of fish in our seas. Here again one ought to clearly distinguish between the more oceanic and active fishes, such as the herring and haddock, which come and go and are largely beyond man's control, and the more local and sedentary forms, such as most of the valuable flat-fish. In regard to the latter, much evidence has been given from time to time in regard to different parts of our coast, showing the depletion of certain areas. It is curious, in this connection, that Prof. McIntosh, while quoting freely from the work of the Trawling Commission of 1883 and of the earlier Commission of 1878,[2] makes no allusion to the evidence given before the much more recent Select Committee of the House of Commons in 1893, the statements in Mr. Calderwood's paper on "British Sea-Fisheries, &c." (1894), and other recent works. It is doubtful whether the older opinions are of much value now under the new conditions. The fishing methods have been so entirely changed with the introduction of powerful steamers and otter-trawls, and the area fished has been so enormously extended during the last few years, that no argument can safely be drawn as to the fish population of our own coastal waters from the supply landed for the markets.

In the discussion of statistics like these so much depends upon the grouping of the figures, and upon the comparisons made, that I for one should not be at all surprised if Dr. Wemyss Fulton, the scientific secretary of the Fishery Board, succeeded from the same series of figures in establishing what we may take to be his main contention that, as a result of the closure there has been a diminution of plaice and lemon soles, and a marked increase of common and long rough dabs, *in the closed areas*. We are afraid, however, that the statistics collected so far are insufficient, and that it is premature as yet to draw any conclusions. And that is the reason why some of us think it important that the Fishery Board's experimental work should not be stopped at this stage. Although ten or even fifteen years may have been spent—and much money—still if reasonable doubt remains, if it seems that more extended experiments might give other and more definite results, surely this is not the time to reverse the policy and stop the accumulation of statistics.

We have reason to think, moreover, from information obtained outside the official reports, that in the Clyde at least the closure is resulting in an increase of the flat-fish on the ground. In the spring of 1887, as the result of their trawling experiments, the Board stated that "the flat-fish in the Clyde are only about half as numerous as in the Forth at the same period of the year," and they considered this as evidence of depletion. In the spring of 1898, after the decade of protection, the Lancashire Fisheries' steamer *John Fell*, trawling during three days for scientific purposes, by special permission of the Board, found what the experienced fishermen on the ship, accustomed to the fishing grounds of the Irish Sea, considered to be rich accumulations of flat-fish, including many true soles (*Solea vulgaris*). The very fact that poaching goes on is sufficient to show that the fishermen regard the closed areas as desirable trawling ground with an abundant fish population.

Well, there are the two policies: the one to preserve these fish sanctuaries by means of restrictions which cause constant friction, and which we would all prefer to see removed; and the other to add more or less artificially to the population of the sea by hatching, or by returning fertilised spawn to the water. The Board is at present pursuing both policies, and it may be that both are necessary.

As the book before us is mainly directed against restrictive measures, we are glad to see at the end of it, in the "Summary," some words as to the natural alternative, "productive" measures; and we can cordially agree with the remarks on p. 231, in regard to hatching. Some years ago (December 1894), Prof. McIntosh wrote an interesting article on the subject in *Science Progress*; a few months ago, in a letter to the present writer, he said, in regard to sea-fish hatcheries:

> "Of course such institutions are strictly experimental, and it may be some time before a decisive result is evident. Meanwhile, work them thoroughly and support them liberally."

This is what the Fishery Board are doing at Dunbar and at Aberdeen, and what we in Lancashire are now doing at the Piel hatchery. At the conclusion of the present book Prof. McIntosh repeats his former statements, and urges that support should be given to such experiments "till the issue is clear."

[1] This must not be regarded as any reflection upon the scientific work of the Scottish Fishery Board, or upon much other useful work accomplished by Dr. Fulton and the staff on board the *Garland*.

[2] By the way, why is "the late Mr. Spencer Walpole" (*sic*) not referred to under his present title of Sir Spencer Walpole, K.C.B.?

I cannot refrain from drawing attention to the fine ideal of the scientific man's action in regard to the fisheries which our author holds up to us. I quote from p. 223:

"A close observer of nature, he weaves no theories, and is not incautious in deduction. The welfare of the fisheries as a whole is his aim, and the influences which act on those engaged financially in them, or have political or other connections with them, are unknown to him."

Prof. McIntosh's friends may be permitted to add that he himself realises that ideal more nearly than any one else we know in the field.

The book is charmingly illustrated with views of the marine laboratory, the harbour, the boats, and some characteristic features of fishing life in the celebrated old Scottish university town of St. Andrews, which the fame and long-continued labours of McIntosh have done so much to render a "Mecca" to the young marine zoologist. W. A. Herdman.

OUR BOOK SHELF.

The Lepidoptera of the British Islands. A Descriptive Account of the Families, Genera, and Species Indigenous to Great Britain and Ireland, their Preparatory States, Habits, and Localities. By Charles G. Barrett, F.E.S., one of the Editors of the *Entomologist's Monthly Magazine.* Vol. V. Heterocera: Noctuæ. Pp. 381. (London: Lovell Reeve and Co., Ltd.)

In the present volume, Mr. Barrett discusses 111 species of British Noctuæ, in the same elaborate manner as in the volumes which we have previously noticed. He has long been recognised as one of our best living authorities on the British *Lepidoptera*, and his book will remain of great and permanent value as a record of the state of this branch of our fauna as it exists at the end of the present century. Among the most interesting moths here noticed are those which are attached to the Fens, several of which are now very much scarcer than formerly in England, though some species (such as *Tapinostola concolor*, Guen.), which were supposed to have become extinct, have now been rediscovered in other localities; while several Fen species, quite unknown during the palmy days of the Fens, have lately been discovered there. We have heard it suggested that this may be due to fresh localities in the Fens having been made accessible by drainage; but in the case of *Calamia brevilinea*, Fenn, Mr. Barrett remarks: "It seems to furnish all the evidence which it would be possible to obtain, in order to suggest the actual genesis, or introduction of a total novelty, to the world's fauna." It appears that the exact locality where the insect now occurs was well worked in 1857, without its being discovered; but in 1864 the first specimen was taken, and no more till 1871, when a few specimens were taken, after which, it has become both commoner and more widely spread in the Fens, and a single specimen has been taken in Belgium. The remarks on the habits of various moths, especially, perhaps, their behaviour at sugar, &c. (under the notice of *Taeniocampa gothica*), will also be read with interest. The well-known cannibal habits of the larva of *Cosmia trapezina* are also remarked on. It should be observed that this work is issued in two editions—one with, and the other without, plates.

W. F. K.

An Introduction to the Mathematical Theory of Attraction. By Francis A. Tarleton, Sc.D., LL.D. Pp. xii + 290. (London: Longmans, Green, and Co., 1899.)

The author tells us that his object is to make the acquisition of a competent knowledge of the theory of attraction as easy as possible for the student. With this view he has given, in addition to the theorems on attractions and potential to be found in most of the text-books, an account of the theory of electrostatics and some outlines of the theory of magnetism. He has attended almost exclusively to the mathematical view of his subject. Possibly the students for whom he writes will have formed sound physical conceptions before they begin to read his book; in that case they will probably find in it what they want in the way of mathematical theory.

To indicate the scope of the book, we may observe that it contains such things as the determination of the attraction of an ellipsoid by direct integration, Laplace's equation in elliptic coordinates, the distribution of electricity on a freely charged spherical bowl, and Kirchhoff's theory of the distribution on two spheres. A student for whom these things are not too difficult could appreciate many things that are omitted, such as the potential of a magnetised body of finite size, Laplace's equation in orthogonal curvilinear coordinates and the logarithmic potential in three dimensions. The author has done well in refraining from barren discussions of artificial laws of force differing from that found in nature.

The plan followed, viz. that of treating gravitational attraction and electrostatic and magnetic forces together, has the disadvantages that the standard case of attraction is repulsion and that special units have to be used in treating gravitation; it has the advantage that it tends to break down the system of water-tight compartments in which students always store their knowledge. A number of results that might be more simply obtained by indirect methods are obtained by direct integration. The potential is introduced comparatively late, the definition even being postponed to the fourth chapter. One excellent feature of the book is that two-dimensional problems and three-dimensional problems are treated separately and side by side.

The author's mathematical methods are the traditional ones of British text-books, except that here and there he presents investigations by Mr. Purser. But surely it is time that writers of books, even on applied mathematics, took some account of modern developments of analysis. If an exhaustive discussion of the existence theorem would be out of place, it would yet seem not unreasonable to expect the banishment of such banalities as "consecutive points" and "infinitely small quantities," the avoidance of meaningless equations between divergent series and divergent integrals, the presentation of a proof that the convergent integrals which represent the components of attraction at a point within an attracting mass are the differential coefficients of the convergent integral which represents the potential at such a point, a little care in extending Gauss's theorem concerning the surface integral of normal force from a single particle to a distribution of density, some discussion of the discontinuity of the second differential coefficients of the potential at the boundary of an attracting body. Why write a new book which follows the old ones in leaving undone the things that ought to be done, and doing the things that ought not to be done?

The book contains several interesting collections of examples. These should prove useful to teachers as well as to students. A. E. H. L.

Outlines of the Earth's History; a Popular Study in Physiography. By Nathaniel Southgate Shaler. Pp. viii + 418. (London: William Heinemann, 1898.)

In these outlines Prof. Shaler has felt the necessity of selecting certain features of the history of the earth for comparatively full treatment in order to supply a more helpful aid to a true knowledge of the earth than is afforded by the "ordinary text-books." At first sight the selection appears inadequate and arbitrarily proportioned. The seven chapters devoted to the concrete subject (after thirty pages of introductory matter) are entitled "The Stellar Realm," "The Earth," "The

Atmosphere," "Glaciers," "The Work of Underground Water," "The Soil," and "The Rocks and their Order." Closer examination, however, shows that these headings are texts for exposition rather than descriptive titles, and a great variety of unexpected information is brought out in the course of the discussions, which are not cramped by an undue effort after conciseness of expression. Thus the Stellar Realm includes a description of the solar system, in which, incidentally, the fact that a planet always keeps the same face turned towards the body around which it revolves, is implied to prove that it does not rotate on its axis. The chapter on the Atmosphere embraces almost as much as the atmosphere itself: not only a little on climate and a great deal on storms, but all that is said about the oceans, tides, lakes and rivers is included under this head; yet glaciers have a chapter to themselves. The greater part of the "Work of Underground Water" is devoted to the phenomena of volcanoes, while earthquakes are dealt with apart under "The Rocks and their Order," a chapter which also includes a section on the moon.

The whole is written in a thoroughly interesting style, like all Prof. Shaler's work, and the frequent references to his own researches give it an element of personal attractiveness. He mentions that, in spite of his long study of swamps, he never saw the phenomenon known as Will-o'-the-Wisp, and is inclined to disbelieve in its existence; the reports of a moving light being, in his opinion, due to subjective impressions induced by gazing into darkness.

But although an interesting book to read, and one which is likely to attract the reader to more systematic scientific studies, this work seems to leave an opportunity for honest doubt as to the wisdom of piecing together portions of discussions unequal in degree of detail with the object of showing the uniformity and continuity of natural processes. There is a want of some more definite coordinating idea, such as would be supplied by considering the progressive evolution of the world and its processes from the condition of a raw planet up to its completion as the home of man. H. R. M.

Admiral Sir William Robert Mends, G.C.B. By Bowen Stilon Mends. Pp. xvi + 380. (London: John Murray, Albemarle Street, 1899.)

THIS biography is of special interest, as the life of Admiral Sir William Mends was exceptionally active and eventful. The facts are taken chiefly from his diary, and from letters to his wife; and his detailed account of the months he spent in the Crimea during the war, gives a good idea of the difficulties which had to be contended with at the time. The author was evidently keenly alive to the scientific side of his profession, for he states that, so far back as 1830, the young midshipmen on board the *Thetis* had to make daily reckonings of the latitude by star altitudes, and of the longitude by lunar observations. The admirable descriptions which he gives of the ships, afford us an excellent opportunity of noting the advance which has been made in the navy, and the new scientific applications which have been continuously introduced.

The Great Salt Lake Trail. By Colonel H. Inman and Colonel W. F. Cody. Pp. xiii + 529. (New York: The Macmillan Company, 1898.)

THIS book is of great interest, but of little or no scientific importance. It is a valuable contribution to the history of early travel in North America, and comprises stories related by members of the first exploring and trapping expeditions. The remarkable adventures of "Buffalo Bill," one of the authors, are also described.

We feel, on finishing the book, that we have obtained a great deal of information, and a good insight into the gradual and steady growth of civilisation in the part of the United States with which it deals.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Interferometer.

As I have been away from home, I have only to-day seen Lord Rayleigh's letter on the interferometer, in your issue of April 6, and I write at once to state that I agree heartily with all he says. I am quite confident that the "structure" discovered by Prof. Michelson in the spectral lines is a real one existing in the light emitted by the source, and I hold this opinion after a careful study of Prof. Michelson's work, combined with the fact that all the "structure" revealed by the interferometer in the light emitted by a source placed in a strong magnetic field is in general accord with my own observations with a 21·5 feet grating.

The law deduced by Prof. Michelson, from his observations with the interferometer, for the *amount* of the magnetic (Zeeman) effect, viz. that "it is approximately the same for all colours and all substances," was, however, at such utter variance with all observations made with a good grating, that I felt bound to question the general performance of an instrument which yielded such a law. My opposition was directed against this law, and if the interferometer had insisted on it, then the interferometer must be discarded as a measuring instrument, or be standardised according to some other scheme.

I am very glad, however, to hear from Prof. Michelson that the law announced by him was probably generalised from insufficient data, and that the interferometer is not at fault. This being conceded, and the law being abandoned, I am thoroughly satisfied, and my confidence in the instrument is re-established.

I may just add that the question as to whether the working of the instrument is prejudiced by "diffraction" or not, was not raised by me, but by others; nor did I intend for a moment to support the idea that the phenomena were due to diffraction. The main phenomena revealed are certainly not due to diffraction, and it is not easy to see where diffraction can come in. The light, of course, passes through a slit, and through other pieces of optical apparatus; and I thought it just possible that some of the minor effects—some of the little "humps," perhaps, in Prof. Michelson's drawings—might be due to transmission through the slit or other pieces of apparatus. It is very easy to determine, however, if diffraction plays any part, for the effects due to it should be similar for all wave-lengths, and should therefore attend all spectral lines varying merely in scale for the different wave-lengths. It is hardly necessary, however, to mention this obvious fact, and I am sure it has been duly taken into account long ago by Prof. Michelson.

THOMAS PRESTON.

Bardowie, Orwell Park, Dublin, April 21.

Absolute Determination of the Ohm.

THE recent great advances in methods of calculating coefficients of mutual and self-induction, due to Prof. Jones and his colleagues in the work, has suggested that a method, which occurred to me some years ago, for the absolute determination of resistance might now be employed with, I think, some advantages over even the Lorentz method. It is as follows:—Take an earth inductor coil, fixed so that it can revolve continuously, thus giving a pure sine voltage, due to cutting the lines of the earth's magnetic field. Take the coils made by the Committee for the determination of the ampere, as described by Prof. Ayrton, and use the two outside coils as the primary and the inside coil as the secondary of a transformer. Pass the current from the earth inductor through one set of coils of a Kelvin balance, and thence through the primary of the transformer. Then through the (non-inductive or easily calculated inductive) resistance required to be measured, thence back to the earth inductor. Connect the secondary of the transformer to the other set of coils of the Kelvin balance, and speed up the earth inductor till the Kelvin balance arm becomes horizontal, and the pull on the two sets of coils is equal. Then take out the resistance we are measuring, and speed up the inductor till the Kelvin balance comes to zero again

This, with the angular velocity of the earth inductor, is all we need for determining the absolute measure of the resistance, since we know by calculation the coefficient of mutual induction between the primary and secondary of the transformer.

The method has some advantages. The value of the earth's field need not be constant. Thermo-currents make no difference, as we are using A.C. voltages, and these may be taken very large compared with any possible thermo-effect in the primary. The same coils would be used for determining both the ohm and ampere, so that any error in calculating the coefficients for them would affect both units. Modifications will readily suggest themselves; as, for instance, two sets of such coils, one on each arm of a balance, and the movable coils acting both as secondary and as the movable coil of a Kelvin balance.

Reginald A. Fessenden.

Western University of Pennsylvania, April 3.

Fourier's Series.

I should like to correct a careless error which I made (Nature, December 29, 1898) in describing the limiting form of the family of curves represented by the equation

$$y = 2\left(\sin x - \tfrac{1}{2}\sin 2x \;.\;.\;.\; \pm \frac{1}{n}\sin nx\right) \;.\;.\;.\; (1)$$

as a zigzag line consisting of alternate inclined and vertical portions. The inclined portions were correctly given, but the vertical portions, which are bisected by the axis of X, extend beyond the points where they meet the inclined portions, their total lengths being expressed by four times the definite integral

$$\int_0^\pi \frac{\sin u}{u} du.$$

If we call this combination of inclined and vertical lines C, and the graph of equation (1) C_n, and if any finite distance d be specified, and we take for n any number greater than $100/d^2$, the distance of every point in C_n from C is less than d, and the distance of every point in C from C_n is also less than d. We may therefore call C the limit (or limiting form) of the sequence of curves of which C_n is the general designation.

But this limiting form of the graphs of the functions expressed by the sum (1) is different from the graph of the function expressed by the limit of that sum. In the latter the vertical portions are wanting, except their middle points.

I think this distinction important; for (with exception of what relates to my unfortunate blunder described above), whatever differences of opinion have been expressed on this subject seem due, for the most part, to the fact that some writers have had in mind the *limit of the graphs*, and others the *graph of the limit* of the sum. A misunderstanding on this point is a natural consequence of the usage which allows us to omit the word *limit* in certain connections, as when we speak of the sum of an infinite series. In terms thus abbreviated, either of the things which I have sought to distinguish may be called the graph of the sum of the infinite series.

J. Willard Gibbs.

New Haven, April 12.

Tasmanian Firesticks.

While preparing for a second edition of the "Aborigines of Tasmania, I received from Mr. Jas. Backhouse Walker, of Hobart, two separate accounts of fire-making by the aborigines, which differ materially from those already known. The accounts come from two very old colonists, Mr. Rayner and Mr. Cotton, and describe fire as being obtained by means of the stick and groove process. Mr. Rayner's account runs thus: "A piece of flat wood was obtained, and a groove was made the full length in the centre. Another piece of wood about a foot in length, with a point like a blunt chisel, was worked with nearly lightning rapidity up and down the groove till it caught in a flame. As soon as the stick caught in a blaze, a piece of burnt fungus, or *punk*, as it is generally termed, was applied, which would keep alight. I cannot say what kind of wood it was. My father has seen them light it. The piece with the groove, he said, was hard, the other soft. The blacks in Australia get fire by the same method. I have seen that done. I think it almost impossible for a white man to do it, for I have seen it tried, and always prove a failure." Cotton's account agrees in the main with Rayner's. We are thus in possession of accounts of three distinct methods of fire production, viz.: (1) flint and tinder; (2) fire drill and socket; (3) stick and groove. At first sight it may appear incredible that a race so low in culture could have known and used three methods; nevertheless such a supposition might occur, for some neighbouring tribes in Australia are known to have at least two methods. As regards the Tasmanians, we may, I think, leave out of consideration the flint process, as both Furneaux and La Billardière seem to have mistaken so-called flint implements for fire flints. We may also eliminate indefinite accounts which simply refer to the process used as one of rubbing two sticks together, although rubbing describes rather the stick and groove method than the drill process. We may also omit the statement about the fire-drill supplied by Bonwick's bushranger as being untrustworthy. We are thus left with the two specimens of fire-drill (in the Pitt-Rivers Museum, Oxford, and in the possession of Sir John Lubbock, respectively) supplied by Dr. Milligan and Protector Robinson, with Melville's description and with A. H. Davies' description. When Melville published his V. D. Almanac in 1833, he gave a short account of the aborigines, but to fire-making he made no reference at all; when he wrote his "Present State of Australia" (mostly an account of Tasmania), printed in London in 1850, he described the drill method of making fire as having been used by the Tasmanians. But, in the meanwhile, Davies, writing in 1845 in the *Tasm. Journ. of Sci.*, says he is "informed" that the Tasmanians raised fire by the drill process. But this statement, on hearsay, was made long after the aborigines had been deported to Flinders Island (1837), and after they had long been familiar with Australian aborigines imported into Tasmania; so that, although his statements may in general be relied on, this one wants confirmatory support, especially as his statement is the first one describing the drill process as being a Tasmanian method. Melville's account appears to me to be taken from Davies. Milligan knew nothing of the aborigines until 1847, when he was put in charge of them at Oyster Cove after their return from Flinders Island, and at a time when it was not likely that, in close proximity to European settlements, they would have continued to produce fire by native methods. Although we are much indebted to Milligan for the vocabularies, on the other hand there is considerable carelessness in his translation of the native sentences, and it is well known locally he was not interested in his charge. Hence his presentation to Barnard Davies of a fire drill as a Tasmanian instrument does not prove the drill to have been Tasmanian. Robinson, in spite of his intimate intercourse with the aborigines, and his voluminous reports on his doings while capturing the wretched remnants, has left us such a comparatively small amount of information concerning them, that I have for a long time past come to the conclusion that he was a very unobservant man, an opinion largely confirmed by his presentation to Barnard Davies of ground Australian stone implements as Tasmanian, but the real origin of which was settled as Australian by Prof. Tylor's paper on the subject read at the Oxford meeting of the British Association. As Robinson was afterwards Protector of Aborigines in Victoria, it is not at all unlikely that he confused his specimens, and called them Tasmanian instead of Australian. On the other hand, we have circumstantial accounts of stick and groove fire-making apparatus by two settlers, well advanced in years, who carry us back to the early part of the century when the natives were still roaming about the country before they were wholly robbed of it, and to a time when they had been little in touch with Australians or Europeans. Either there were two methods of fire production used by the natives, or the stick and groove was the only one.

H. Ling Roth.

Halifax, England, April 13.

WIRELESS TELEGRAPHY.

Although at the present moment there is not a single commercial line of the so-called wireless telegraphy at work, and probably not a single penny has yet been earned by those exploiting it, the one pound shares of the Company have been quoted at six pounds, and perhaps more. At the same time the shares of many of the Submarine Cable Companies have fallen considerably owing to the popular delusion that wireless telegraphy is going to displace wires. Thus a popular scare—the outcome of ignorance—has appreciated the one property and depreciated the other to the value of about

two millions sterling. It reminds one of the influence of electric light on gas undertakings some twenty years ago. Gas stock depreciated then many millions. Now they never were so high in value. There was some excuse then. The electric light was a great boon. It was a dangerous rival. There is no excuse now. Nothing whatever about wireless telegraphy has given the smallest indication that it is going to supplant wires. It simply fills a want. Communications between lightships and shore, between ship and ship, between moving ships and shore, between isolated lighthouses and the mainland, become possible. They were not so before.

Messages between the South Foreland and Boulogne have been sent. There is no reason why they should not. Mr. Preece, many years ago, indicated how it could be done. Mr. Marconi has done it in another way. But an isolated experiment, however successful, and a single circuit, though it transmitted messages accurately at the rate of twenty words a minute, is not going to replace one of the present submarine wires, each of which can transmit similar messages at 600 words a minute. Wireless telegraphy may maintain communication with outlying islands when cables break down. It did so by the Post Office with the island of Mull in 1895, before Mr. Marconi was heard of; but it is not going to replace one single cable between Great Britain and the continent. Marconi's system has now been before the public for nearly two years, but we have not heard of anything new from a scientific point of view since it was first published. The last report is that it is possible to direct the signals to one selected point. Two years ago it was said to be able to do the same thing by tuning. The fact is that we have in these repeated sensational experiments a pure scientific apparatus boomed by energetic financial speculators for their own individual gain, and not for the benefit of the public—the worst feature of this money-grubbing age.

THE MICHELSON ECHELON SPECTROSCOPE.

SINCE Prof. Michelson's announcement of his new form of spectroscope, in the *American Journal of Science*, March 1898, and *Astro-Physical Journal*, vol. viii. p. 37, 1898, all having any connection with spectroscopic work have been waiting with great interest to see the performance of the instrument. This curiosity has now been satisfied in a most complete manner, an echelon of fairly large dimensions having been successfully constructed by Mr. A. Hilger, of Islington, which the writer has had the pleasure of examining. Before describing this, it may be useful, for the benefit of many who have not noticed the previous reports, to briefly state the characteristics of the new spectroscope.

In an ordinary diffraction grating, consisting of equidistant lines ruled on a plate of glass or speculum metal, the resolving power is determined by the product $(m\,n)$ of the total number of lines (n) and the order of spectrum observed (m). As in this type of grating the succeeding orders after the first decrease in brightness very rapidly, little progress has been made in the endeavour to increase the order observed. Many attempts have, indeed, been made to concentrate the light in one of the first three orders by means of special adjustment of the ruling, so that higher magnifications could be used, but with little or no certainty or equality of result. If, however, instead of obtaining the phase difference by alternations of opaque and transparent spaces, the necessary retardation is brought about by a progressive damping, as it were, of the wave-front by increasing thicknesses of an absorbing transparent material, it would seem that it is possible to throw practically the whole of the transmitted light into any *one* order. In such a case the grating space must be proportionately increased so that it remains commensurate with the degree of the order; and as the lines would need to be made with no more accuracy than before, the grating could be completed in less time, and therefore with less chance of deformity due to temperature and other changes.

Instead, however, of attempting to rule lines on glass or metal, which would be an extremely difficult matter for this purpose, Prof. Michelson took an entirely original step by building up the spaces with a number of strips of glass having optically plane surfaces. The appearance presented by such a dispersive arrangement will then be as shown in the following diagram (Fig. 1), the arrows indicating the directions of the incident and transmitted rays.

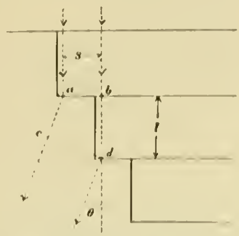


Fig. 1.—Showing paths of direct and diffracted rays through the echelon.

"The interesting feature of the new arrangement is the smallness of the number of elements necessary to give results which may be comparable to those given by the best ordinary gratings. This can be simply shown as follows: Let $ab = s$, and $bd = t$ be the surfaces of one of the steps between two of the parallel plates of the echelon. If then m is the order of spectrum to be observed, we shall have

$$m\lambda = \mu\,.\,bd - ac,$$

or

$$m\lambda = \mu.t - t\cos\theta + s\sin\theta.$$

Therefore

$$\frac{d\theta}{d\lambda} = \frac{m - t\dfrac{d\mu}{d\lambda}}{t\sin\theta + s\cos\theta}$$

and

$$\frac{d\theta_1}{dm} = \frac{\lambda}{t\sin\theta + s\cos\theta};$$

If $\delta\theta$ is the displacement corresponding to $\delta\lambda$, and $\delta\theta_1$ is that corresponding to $\delta m = 1$, then assuming Cauchy's formula,

$$\mu = a + \frac{b}{\lambda^2},$$

and taking as a first approximation

$$m = (\mu - 1)\frac{t}{\lambda},$$

we have

$$\frac{\delta\theta}{\delta\theta_1} = \left[(\mu - 1) + 2(\mu - a)\right]\frac{t}{\lambda}\,.\,\frac{\delta\lambda}{\lambda}.$$

"For most specimens of flint glass the coefficient of $\frac{t}{\lambda}$ in the last expression is approximately equal to unity, so that if $\frac{\delta\lambda}{\lambda} = \cdot 001$, say, as in the case of the two yellow sodium lines, and $t = 5$ mm. $= 10{,}000\,\lambda$, then

$$d\theta = 10\,d\theta_1;$$

that is, the two sodium lines would be seen separated by ten times the distance between the successive spectra.

The resolving power of this combination is mn, just as in the case of ordinary gratings; and thus, with a battery of *twenty* elements, each 5 mm. thick (corresponding to $m = 5000$), the resolving power would theoretically be 100,000, which is as high as that of the best gratings available at present."

Although, as stated above, the resolving power is independent of the *number* of plates, being determined by the total thickness, yet for any given purpose the number of elements has to be considered. This is evident when it is remembered how closely the successive spectra follow each other. With a small number of plates the overlapping may be so inconvenient as to render the lines unrecognisable, so that, in designing an echelon, this has to be taken into account. If the spectrum to be examined consists of a few sharp lines, the overlapping may be considerable before it causes confusion, and a *few thick* plates will suffice. If, however, the investigation of doubling or widening of special lines in ordinary spectra is needed, then the echelon could advantageously be constructed of a larger number of elements of less thickness to give the necessary resolution.

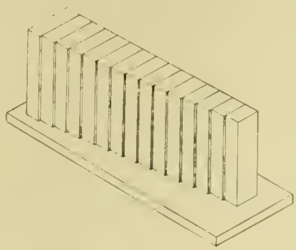


Fig. 2. The Michelson Echelon. (Scale $\frac{1}{3}$.)

The echelon made by Mr. Hilger consists of fifteen plates, each 7·5 mm. in thickness and 45 mm. high, the width (S) of each step being 1 mm., and the order of spectrum observed being therefore about the 8000th. Its appearance is shown in the annexed cut (Fig. 2), the cell in which it is usually held having been removed. In use the echelon is laid horizontally on the table of an ordinary spectrometer provided with collimator and telescope, and, as the line of vision is almost direct, it can be placed at once approximately into position. If, however, the slit of the collimator be illuminated with either white light or any source consisting of many radiations, the overlapping of the successive spectra will simply give an almost white band across the field. To obviate this, it is necessary to only illuminate the slit with light which is sensibly monochromatic. In the case of sodium or mercury vapour there need be nothing more than the source itself, as the light is sufficiently simple in their case, but in general some light-filter will have to be used. This may be done by first passing the light through an auxiliary spectroscope, and focussing the spectrum given by it on the slit of the echelon spectrometer, thus isolating a small region which will be approximately monochromatic. This arrangement is illustrated in Fig. 3, which shows how the echelon (E) is fitted up in actual work. The form of apparatus for obtaining monochromatic light will depend on the resources of the observer. Obviously a direct vision prism will be most convenient, as then the source of light can be kept stationary while the spectrum is caused to traverse the slit in order to transmit the different lines. If only an ordinary spectroscope with deviating prism is available, then the light source must be secured to the collimator and moved round with it. There is a very simple method, however, of converting an ordinary prism into a direct-vision one, viz. by fixing a plane mirror to the back of the prism. The arrangement is described by Dr. Fuchs in *Zeitschr. für Instr Kunde*, vol. i. p. 352 (1881), and has later been developed by Wadsworth ("Astronomy and Astro-Physics," vol. xiii. p. 844). In this case, all that is necessary is to revolve the prism-mirror combination about the centre of the back of the prism, the axial emergent ray being always at minimum deviation. This combination is shown in Fig. 3, P being the prism-mirror system between a collimator and telescope; the collimator (C) of the echelon (E) being then directed axially with the telescope of the auxiliary instrument. The observing telescope (T) will be almost directly axial with the collimator, as the deviation seldom amounts to more than half a degree for the line under examination.

With the above echelon the "D" lines of sodium are separated by about sixteen minutes of arc, this being about ten times the dispersion of an ordinary good spectroscope. The successive spectra are only separated by about two minutes of arc, so that generally two orders of spectra are visible in the field together; in practice the echelon can be slightly inclined, thus reducing the intensity of one of these almost to zero, so that measurements can be made on the remaining one with less risk of confusion.

One is surprised at the first experience with the instrument by the brightness of the spectra, considering the enormous dispersion and the path traversed by the light. This is no doubt partly due to the incidence on the plates being very nearly normal, thus diminishing the losses by reflection.

In making the plates it was a very delicate matter to obtain all of exactly the same thickness. This was done by first producing a large plane-parallel plate, and then cutting out the required pieces from it. In the making of this plate the ordinary tests for plane parallelism were found quite inadequate, and every part of it was tested by viewing the interference bands produced between the two surfaces while illuminated by a parallel beam of monochromatic light. Each elementary section of the surface was then refigured until the interference patterns were similar throughout. This will give some idea of the patience and skill required to produce a successful result.

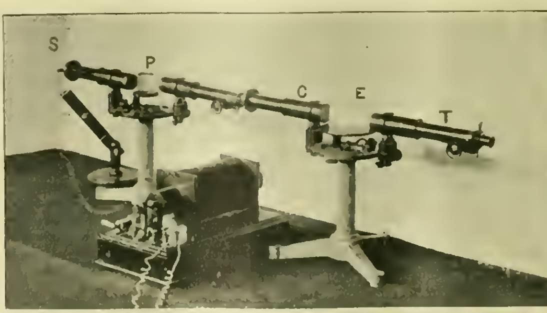


Fig. . The echelon in use.

From the fact of its being necessary to use monochromatic light, and also from the limited range owing to the short distance between the spectra, it would appear that the use of the new spectroscope will of necessity be somewhat confined to special branches of research. For the investigation of the Zeeman effect, and the resolution of hitherto undivided multiple lines, it should prove of great service, the relatively bright spectrum obtained rendering it possible to examine the fainter lines which have perforce been neglected up to the present.

Naturally, the first essay in constructing such an entirely new piece of optical work was fraught with many difficulties; but, encouraged by his success, Mr. Hilger expresses himself as quite prepared to undertake the building up of echelons of much higher power than the one he has just completed. CHARLES P. BUTLER.

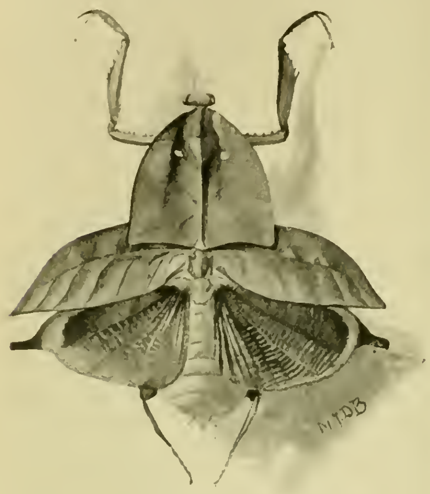
FLIGHT OF BIRDS.

"THE way of a bird in the air" has been for ages a perplexing one; and, until recently, its mechanical explanation has been too much left to persons whom the more sober members of the body scientific were apt to class as "cranks," to use an Americanism. If confirmation of such judgment were necessary, it was afforded by a report, made to the Institute of France about 1830 by Navier, who was no "crank," member and reporter of a commission of eminent scientific men, in which the subject was discussed. Navier drew a distinction, since generally accepted, between hovering, in which the bird remains stationary in the air, as a hawk or kite "winnowing," on the one hand, and progressive flight, accompanied by flapping of the wings, in which the bird moves forward rapidly, as a carrier pigeon or swallow on a journey, on the other. A third mode of flight, called soaring, has, of late, attracted much attention. It consists in the bird maintaining forward motion, straight or circling, sometimes for minutes together, with very occasional and slight flaps of the wing; in some cases with none at all. In these three kinds of flight, observations easily made by any one show that soaring appears to require the least exertion, though not many birds can manage it well; progressive flapping flight is common, and many birds can keep it up for hours; while only a few can manage hovering, which appears to involve much exertion, and, as the Duke of Argyll expresses it, seems to be the most difficult feat of wingmanship a bird can execute. Navier, however, concluded hovering to be far easier than progressive flight, requiring only about one-twentieth of the exertion of this latter; soaring he does not appear to have considered. His results, moreover, made very heavy demands on the animal, considered as a machine. According to him, a bird must be able to give out energy at, or exceeding, the rate of 1000 foot pounds per second per pound of its own weight, whereas no ordinary land animal whose work is directly measurable gives out continuously for hours more than about half a foot pound per second per pound of its own weight. This excessively disproportionate activity of birds, in the proportion of over two thousand to one, as compared with other animals, seems sufficient to invalidate the basis of calculation; but the argument is further strengthened on finding that a carrier pigeon, for instance, does not contain enough combustible matter to maintain its own flight, and live, for anything like an hour, if Navier be right. A thousand foot pounds is rather more than one British thermal unit, so that one heat unit, if wholly converted into useful mechanical power, would carry a pound weight for somewhat less than four-fifths of a second. The bird's feathers and bones must be preserved, and water or blood are not combustibles, so that not more than four ounces in the pound of its weight can be reckoned as available combustible matter. If this be as good fuel as paraffin oil (and some birds are oily), each pound of the bird's body can supply about 5000 heat units, able to carry it for 4000 seconds or thereabouts, or less than an hour and ten minutes. At the end of this time the bird would be a wet feathered skeleton with a few ashes inside, rattling among the bones, perhaps. On the other hand, Langley's experiments, which were very carefully made, and agree in all material points with others of the same nature, conclusively show that what is often called an aëroplane—that is, a plane slightly inclined to the direction of its motion in air—can, at reasonable velocities, be made to soar while carrying a load of one pound, by an expenditure of from 5 to 10 foot pounds of work per second. He also shows that the power required to sustain a given weight varies almost exactly inversely as the velocity of flight of the aëroplane; while Navier, in his calculations, made it vary directly as the cube of the velocity. On all accounts, then, it appears highly probable that the flight of birds is effected, in ordinary cases, by a process much more nearly allied to that of the soaring of Langley's planes than that investigated by Navier. The wings must be taken to act principally as aëroplanes, and the flapping action be used to enable the bird to supply the comparatively small power required for the propulsion of soaring aëroplanes. In confirmation of this view, which the present writer takes to be that now recognised as affording the best explanation of birds' flight, he has shown, in a paper recently read before the Royal Society, that a machine consisting of a vertical cylinder and piston, with a nearly horizontal aëroplane attached to the rod, could, by the reciprocation of the piston, sustain and propel itself in horizontal flight, with an expenditure of energy little exceeding, perhaps falling below, that found requisite in Langley's experiments. In cases comparable to those of birds, rapidity of reciprocation affects the result but slightly, agreeing with the known fact that some birds able to fly long distances flap slowly, while others flap quickly; whereas this would be improbable if any considerable intrinsic difference in economy of labour existed between slow and quick flapping. As to hovering, the conditions are too far removed from those of experiments on soaring to allow reliance to be placed on numerical results; there does not appear any absolute necessity for a higher rate of energy-expenditure than in ordinary flight, but the conditions of economical working, particularly as to a sufficiently quick flapping, seem to be more difficult of attainment. In prolonged soaring flight it appears likely, from theoretical investigations by Lord Kelvin, as well as consistent with observation, that local air currents may be largely concerned, as a skilful bird might, by gliding in and out among currents having different velocities, appropriate for his own use and support enough of the extra energy of the quicker currents, to keep himself going continuously, without any exertion, beyond that involved in steering, on his own part.

With respect to the very interesting, though probably not very practical, question of man's mechanical flight, Langley's and Maxim's experiments show it to be at least within the range of possibility; but, if the conclusions of the paper above alluded to be correct, the most economical method of effecting it would involve using the supporting aëroplanes as birds use wings—that is, as propellers and aëroplanes combined in one. Purely constructive difficulties interfere seriously with designs for movable wings of any considerable size, especially if their motion is a reciprocating one, while there is another whole tribe of difficulties connected with the balancing and steering, very possibly greater than those which beset the beginner on a bicycle; so that, on the whole, we can scarcely feel as if we were within any very measurable distance of emulating the feats of Dædalus, without almost certainly suffering the fate of his less fortunate son. MAURICE F. FITZGERALD.

A POPULAR WORK ON INSECTS.[1]

THIS is a popular book on somewhat new lines, being entirely devoted to *Orthoptera* and *Lepidoptera*. It is well written, and up to date; and has the merit of dealing mainly with branches of the subject which are not hackneyed. The illustrations are new and well selected, and chiefly represent species which have not been figured



A remarkable Mantis from Borneo.

in any easily accessible work. These were all executed for the author by her sister; and the life-size figures are very good. It has been necessary to reduce the dimensions of some of the insects figured; which is a pity, for though this is sometimes necessary in the case of a book of limited size, it always seems to us to spoil the effect of even a good figure. In the *Orthoptera* the families dealt with are *Phasmidae*, *Mantidae*, *Acridiidae* and *Locustidae*. The habits, transformations, and senses of these insects are discussed generally, limited space necessarily precluding many references to individual species. Several very curious insects are figured, including *Deroplatys truncata*, a remarkable Mantis from Borneo, which is represented at p. 32, and also on the cover. When the book is held straight up, the latter figure has been fancifully compared to a ballet dancer; but this odd resemblance is less obvious in the figure in the text, owing to the shading.

The chapters on *Lepidoptera*, some of which do not now appear for the first time, commence with "Symbols of Psyche," including a sketch of the story of Cupid and Psyche from Apuleius, prefatory to general observations on butterflies. The other chapters relate to "Day-flying Moths" (*Castniidae*, *Uraniidae*, &c.); "The Case Moths" (*Psychidae*); "The Hawk Moths" (*Sphingidae*); and "The Death's Head Moth."

The book will be read with interest both by entomologists and by any others who are interested in natural history; and it is not unlikely that many may acquire information from it, which was previously unknown to them. The book appears to have been very carefully composed, and we have not noticed any very serious errors. In one place, however, the name of the American entomologist, Bruner, is spelt Brunner, probably by confusion with the Austrian entomologist, Brunner von Wattenwyl; and in the notice of the colours of the *Mantidae*, the curious genus *Metallyticus*, which similates those brilliantly coloured beetles, the *Buprestidae*, might perhaps have been mentioned. But there is little to find fault with in so commendable a piece of work as the book before us.

W. F. K.

1 "True Tales of the Insects." By L. N. Badenoch, author of "Romance of the Insect World." With forty-four illustrations by Margaret J. D. Badenoch. Pp. xviii + 255. (London: Chapman and Hall, Ltd.)

THE SCIENCE BUILDINGS AT SOUTH KENSINGTON.

WE are glad that the Government has conceded to the wish of men of science, and decided to place the new science buildings at South Kensington on the west side of Exhibition Road, between the Natural History Museum and Imperial Institute Road. It will be remembered that a year ago it was proposed to build the new laboratories for the Royal College of Science on the restricted site available on the east side of Exhibition Road, notwithstanding the fact that the large plot on the

First sketch of proposed Royal College of Science, South Kensington. View from Imperial Institute Road.

west side had been obtained by the Government from the 1851 Exhibition Commissioners for a nominal sum on the understanding that it was to be used for the erection of science buildings. The proposal was condemned by both science and art; and memorials protesting against it were signed by eminent Fellows of the Royal Society, and by the leading representatives of art. These memorials,

in which the facts of the case were clearly set forth, were printed in the last volume of NATURE, which also contains several articles bearing upon the question then at issue (vol. lviii. pp. 54, 155, 176, 294). It is satisfactory to know that the Government has been guided by the unmistakable expression of opinion which their proposal elicited, and has arranged for the erection of the new science buildings on the land obtained for that purpose on the west side of Exhibition Road. By the kindness of Mr. Aston Webb, we are able to give a copy of his first sketch of the building which it is proposed to erect facing the Imperial Institute in Imperial Institute Road. It will be seen that the building will provide science with a worthy home, in which instruction and investigation can be carried on under good conditions. We hope in a future issue to give detailed plans of the chemical and physical laboratories. The position of the astro-physical laboratory has not yet been decided, but particulars will be given as soon as they are available.

NOTES.

IT has been decided to give the name "Victoria and Albert Museum" to the new building at South Kensington, the foundation stone of which will be laid by the Queen on May 17.

THE Council of the Institution of Civil Engineers have made the following awards for papers read and discussed before the Institution during the past Session:—A George Stephenson Medal and Premium to Mr. R. A. Hadfield; a Telford Medal and Premium to Mr. J. T. Milton; Watt Medals and Premiums to Sir Albert J. Durston, K.C.B., and Mr. H. J. Oram; a Crampton Prize to Mr. Francis Fox; a Manby Premium to Sir William Roberts-Austen, K.C.B.; Telford Premiums to Messrs. J. M. Dobson, W. G. Kirkaldy, and A. P. Head. The presentation of these awards, together with those for papers which have not been subject to discussion, and will be announced later, will take place at the inaugural meeting of next Session.

THE American National Academy of Sciences has awarded the fifth Watson medal to Dr. David Gill, F.R.S., Astronomer Royal at the Cape.

THE Council of the Royal College of Surgeons of England have resolved that the centenary of the foundation of the College shall be celebrated on a suitable date between March 22 and June 30, 1900.

WE regret to see the announcement of the death, at Paris, of the distinguished chemist, Prof. M. Charles Friedel, member of the Paris Academy of Sciences.

MR. ROLLO APPLEYARD, the official reporter of the Physical Society of London, has had to resign his office owing to the pressure of other work.

THE Sydney correspondent of the *Times* states that to-morrow (April 28) Sir Frederick Darley, the Lieutenant-Governor, will dedicate for public use the site of Captain Cook's landing on Kurnell Beach, in Botany Bay, on April 28, 1770.

AN excursion to Brittany has been arranged by the Geologists' Association for the Whitsuntide holidays, May 17–24, the directors being Dr. Charles Barrois and M. P. Lebesconte. The places to be visited by the members include several of special geological interest.

THE autumn Congress of the Sanitary Institute will be opened at Southampton on August 29. The preliminary circular announces that the president of Section I. (Sanitary Science and Preventive Medicine) will be Sir Joseph Ewart; of Section II. (Engineering and Architecture), Mr. James Lemon; and of Section III. (Physics, Chemistry, and Biology), Prof. Percy J. Frankland, F.R.S.

IT is announced that the Committee to which was entrusted the duty of deciding upon a suitable memorial to be erected by the citizens of Philadelphia, in honour of the late Dr. Pepper, in recognition of his many services to the community, has recommended the erection, at a cost of 10,000 dollars (2000*l.*), of a statue, which it is proposed shall be placed upon the Plaza of City Hall.

THE Danish Meteorological Institute has issued a Circular proposing that all the Meteorological Institutes of Europe and America shall subscribe to the cost of daily telegraphic weather reports from Iceland and the Faroes. The Great Northern Telegraph Company has undertaken, as soon as fourteen Institutes have notified their adhesion to the proposal, to lay a telegraph cable to the Islands. The cost of the daily reports is to be partly determined by the size of the various countries subscribing for them.

UNDER the direction of the Government of Belgium, Prof. G. Gilson, Louvain University, is about to commence a series of experiments on the currents of the North Sea. On Saturday, April 29, the first set of bottles will be set off from the West Hindar light vessel, 2° 26′ E. longitude, 51° 23′ N. latitude—*i.e.* about twenty miles north-west of Ostend. Each bottle contains a printed card, and it is hoped that any one who picks up one of these bottles will take out the card and fill up the blanks reserved for the place and date of finding, name and place if found on the shore, latitude and longitude if on the sea, or bearings, if any. Finders are not required to pay postage.

THE *Morning Post* states that a Committee of the St. Petersburg Astronomical Society, appointed to examine the question of the reform of the Russian Calendar, having applied to all the Government Departments for their opinions on the question, the Ministries of Communications, the Interior, Finance, and Foreign Affairs have replied in favour of the adoption of the proposed reform at an early date. The Committee will proceed with its labours immediately, and will probably have concluded them by the beginning of June.

A PRIZE, founded by Baron Léon de Lenval of Nice, will be awarded at the International Otological Congress to be held in London from August 8 to 11. The prize is a sum of 3000 francs, bearing the name of "The Lenval Prize," and it will be awarded to the author of the most marked advances in the practical treatment of affections of hearing since the last Congress, or to the inventor of any new apparatus which is readily portable and improves considerably the hearing-power of deaf persons. All persons desirous of competing for the prize are requested to communicate with Mr. Cresswell Baber, honorary secretary general, 46 Brunswick Square, Brighton, stating the facts on which their claim is based.

WE learn from the *Lancet* that a Congress, having for its subject the prevention of tuberculosis, will be held in Berlin, under the patronage of H.I.M. the Empress of Germany, from May 24 to May 27. The president is the Imperial Chancellor, Count Hohenlohe-Schillingsfürst, and the vice-president is Dr. von Leyden. The objects of the conference are to make the dangers of tuberculosis as a disease known among people in general, and the best means for combating the disease. Besides these subjects will be discussed the present range of knowledge concerning tuberculosis and the various methods of prevention, more especially the treatment of sanatoria.

A WARD of the Royal Southern Hospital, Liverpool, to be used in connection with the new school for the treatment of tropical diseases, was opened by Lord Lister on Saturday. The *Lancet* states that Major Ronald Ross, who has just been elected to the post of lecturer in tropical medicine in the school, has

had eighteen years' training in his subject, while his discoveries in relation to the malarial parasite have placed him amongst the foremost investigators. In January last Dr. Laveran communicated Major Ross's researches to the French Academy of Medicine, the Italian observers have confirmed his observations, and more recently Prof. Koch has shown their importance and accuracy. In no place in this country will such work be more generally appreciated than in Liverpool.

Prof. Heinrich Kiepert, the distinguished geographer, died at Berlin on Friday last, at the age of eighty-one. His geographical work consisted largely in the construction of maps illustrative of ancient history, and more especially of South-Eastern Europe and Western Asia. Prof. Kiepert was born at Berlin, and studied at the University of that city. After having charge for a few years of the Geographical Institute in Weimar, Kiepert returned to Berlin, and in 1859 was appointed Extraordinary Professor, and in 1874 Ordinary Professor, of Geography in the University. His activity in the production of maps and atlases, together with memoirs to accompany these, continued almost unabated to the end.

The death is announced, at eighty-two years of age, of Mr. Jabez Hogg, distinguished as an ophthalmic surgeon, microscopist, and writer of scientific works. He was vice-president of the Medical Society in 1851-52, was elected a Fellow of the Linnean Society in 1866, and honorary secretary to the Royal Microscopical Society from 1867 to 1872. He was the first president of the Medical Microscopical Society. Mr. Hogg was a prolific writer, and was the author of works on photography, domestic medicine, English forests and forest trees, experimental and natural philosophy; history, construction, and applications of the microscope; colour blindness, microscopic examination of water, and numerous papers on disease of the eye, contributed to the medical journals.

Mr. Joseph Wolf, an artist whose pictures of animals have delighted many naturalists, died on Thursday last, at the age of seventy-nine. Referring to his career, the *Times* states that he was early apprenticed to a lithographer, studied in Antwerp, and came by invitation to London to take up the work of illustration for Gray's "Genera of Birds," a standard work then in progress. This led to work for the *Proceedings* of the Zoological and Linnean Societies. Among other books for which he made drawings were "The Birds of North-East Africa," "The Birds of Japan," and Gould's "Birds of Great Britain"; while he also helped to illustrate Livingstone's "Missionary Travels," Wallace's "Malay Archipelago," and Baldwin's "African Hunting." His studio was once a resort of explorers, artists, and scientific men; among his friends and admirers were Darwin, Owen, Oswell, and the Duke of Argyll. It is, however, chiefly by the books he has enriched with inimitable illustrations that he is best known. In the seventies his "Life and Habits of Wild Animals" was in the hands of every naturalist.

Reuter's Agency is informed that the following are Dr. Sven Hedin's plans for his new expedition in Central Asia:—Dr. Sven Hedin will start from Stockholm at the end of June, and will travel direct through Russia and Turkestan to Kashgar, taking a new route over the mountains. On reaching Kashgar he will proceed in an easterly direction for the purpose of making fresh investigations in Chinese Turkestan, where he hopes to find further antiquities. Thence he will visit the Lop-nor region, and will cross the great Sand Desert by more than one route. After going to Tibet and exploring that portion of the country to the south of his former route, he will return *via* India. As in the case of his famous journey across Asia, Dr. Sven Hedin's objects on this expedition are purely scientific. Dr. Hedin is, however, better prepared than he was on that occasion, and hopes to achieve even better results than he did then. The expenses of the expedition, which will amount to 2000*l.*, have been defrayed by King Oscar, Mr. Emanuel Nobel, and others.

The first annual report of the Secretary of the Washington Academy of Sciences has been issued. For several years efforts have been made to federate the various scientific societies in Washington, and a committee appointed with this end in view formulated a plan of co-operation in 1882, which was adopted by the Anthropological and Biological Societies, but was rejected by the Philosophical, and thus failed to be realised. Six years later a movement to secure a permanent committee to deal with questions of common interest was more successful, and a Joint Commission, upon which the several scientific societies were represented, was created. Out of this Commission, which was primarily organised for business purposes, the Washington Academy has grown. The Academy was incorporated a year ago, with Prof. J. R. Eastman as president, Prof. G. K. Gilbert as secretary, and Mr. B. R. Green as treasurer. The vice-presidents, elected on the nomination of the several scientific societies, are: for the Anthropological Society, Prof. J. W. Powell; Biological, Dr. L. O. Howard; Chemical, Mr. H. N. Stokes; Entomological, Mr. W. H. Ashmead; Geographic, Mr. A. Graham Bell; Geological, Mr. C. D. Walcott; and Philosophical, Prof. F. H. Bigelow. In addition to the seven societies here mentioned, the affiliated societies are the Columbia Historical Society, and the Medical Society.

On Tuesday next, May 2, Prof. Silvanus P. Thompson, F.R.S., will deliver the first of a course of two lectures at the Royal Institution on electric eddy currents. These are the Tyndall lectures. The Friday evening discourse on May 5 will be delivered by Dr. W. J. Russell, F.R.S.; his subject is "Pictures produced on photographic plates in the dark."

The expenses connected with the preparation and publication of the second volume of the "Recueil des données numériques," just issued by the French Physical Society, have been paid by a friend of science who desires to remain anonymous. The amount paid was 9600 francs, in addition to which M. Gauthier-Villars deducted 734 francs from the account as the contribution of the printer towards this valuable work.

Mr. F. J. Bennett, who joined the Geological Survey of England in 1868, has just resigned his post on the staff. During his long service he has mapped large areas of the Cretaceous, Tertiary, and Drift deposits in the Eastern counties, and in Surrey, Berkshire, and Wiltshire. He retires to West Malling in Kent.

Dr. M. E. Wadsworth has protested against the introduction, by Dr. E. Hussak and Mr. G. T. Prior, of the name "Zirkelite" for a new mineral, on the ground that he (Dr. Wadsworth) had previously used the name for a basaltic glassy lava, which often forms the entire mass of thin dykes, and the exterior parts of larger dykes of diabase and melaphyr.

Mr. A. A. Julien has discussed (*Journal* of the Franklin Institute, April 1899) the elements of strength in the constitution and structure of building-stones. He remarks that blocks of hewn stone are always seamed and weakened by minute cracks. Rude processes of quarrying, the use of heavy hammers, and blasting, are apt to act injuriously on stone, and to cause an inferiority in hewn as compared with sawn cubes. He draws attention to the minute structure of various rocks; and, after all, concludes that the most satisfactory of all tests, when available, under known conditions and of sufficient

antiquity, is the study of weathered surfaces of ancient stone-buildings and monuments.

THE gold-bearing slates of Nova Scotia have been investigated by Mr. J. Edmund Woodman (*Proc. Boston Soc. Nat. Hist.*, vol. xxviii., March 1899). The rocks extend along the eastern side of the country in a belt which averages twenty-five miles in width, and covers an area of about six thousand square miles. They are highly metamorphosed, and are regarded as probably belonging to the Algonkian system. The rocks are intersected by veins of quartz and calcite containing gold, both free and in the various sulphides, which are abundant. Among the veins much interest attaches to the gold-bearing stratified veins, often called "leads"; and it is observed that, although the veins lie parallel to the planes of stratification, they must have come from below, and have been formed from hot waters which bore various substances in solution. Probably in this complicated region the gold is of varied origin. In some cases it must have been deposited with the sediments, and has since been concentrated by subaërial agencies.

IT is many years since the question of the chemical reactions which occur in the pan amalgamation of silver ores has been raised. Since Hague's experiments his conclusions have been accepted that cuprous chloride is formed by the interaction of common salt, bluestone and metallic iron, and that cuprous chloride is instrumental in reducing sulphide of silver. As the result of a series of experiments, however, Mr. H. F. Collins put forward a new account of the pan process at the last meeting of the Institution of Mining and Metallurgy. According to his view, a "chloride" ore is readily treated in an iron pan without bluestone or metallic copper, the silver compounds being directly reduced by the iron. In the case of sulphide ores, treatment is facilitated by the addition of sulphate of copper, which is rapidly reduced to metallic copper by the iron. The copper, whether amalgamated or not, acts on sulphide of silver, reducing it to metal and enabling it to be taken up by the mercury. On the other hand, cuprous chloride, a still more energetic agent in reducing sulphide of silver, never exists in the pan, and in this way the comparatively bad results obtained in the treatment of sulphide ores in the presence of metallic iron are explained. The use of copper-bottomed vessels in the treatment of sulphide ores has been practised for over a century. In such vessels cuprous chloride is formed in considerable quantities.

THE cosmopolitan character of Cairo is exemplified by an announcement which we have received referring to the Ghizeh Zoological Garden. The information is printed in six languages, namely English, French, German, Italian, Greek, and Arabic. From it we learn that the garden is open every day, Sundays included, that the collection of animals is such as pleases the popular mind, and includes two lionesses formerly belonging to the Khalifa at Omdurman, and that a large variety of plants may be seen. The paths extend altogether to a length of six miles (of which three and a half miles are paved with coloured mosaic), the grottos were erected in the time of Ismail Pasha, and more than twenty bridges cross the ornamental water in the grounds. The garden is evidently a very pleasant and instructive place.

MR. A. HALL, of Highbury, has designed an almanac with the object of eliminating the inconvenience consequent on the various days of the months falling on different week days, owing to the changing number of days in each month. His scheme is to make New Year's Day separate from the rest, calling it January 0, and then divide the remaining 364 days into thirteen months of twenty-eight days each. Following this plan, therefore, any particular day of any month will always fall on the same day of the week, and this would, of course, be convenient for many purposes. The extra month he proposes to denote by the name "Christember." The almanac sent us is printed on this principle, and a useful item included is the table of corresponding dates between the Gregorian, Julian, Jewish and Mohammedan calendars.

A SYSTEM of printing telegraphy, known as "Prof. Rowland's Multiplex," is stated by *Engineering* to have been recently tested between Philadelphia and Jersey City with highly satisfactory results. On this system a message is sent and received in legible and easily read type, transmitted from keyboards similar to those of a typewriter, the characters including simply the ordinary alphabet and numerals. The device on trial was made at the Johns Hopkins University in order to demonstrate what merits it possessed and also its weakness, if any, and it is arranged for eight messages, four in each direction, and duplexed in the usual way. The messages are printed on either a tape or a page, and a speed of sixty words a minute has been obtained in some of the experiments, but the limit of speed or the number of messages was not reached. There is no other multiplex printing system sending from a keyboard and received on a page, and this one is only a part of that invented by Prof. Rowland. It is stated that the whole invention contemplates a relay method, by which any amount of territory may be covered, and comprises a system by which eight people in one city can be in communication with eight others in another place over one wire and with absolute secrecy. Among the advantages claimed for the multiplex system is that of less liability of error, since there is only one person engaged, and he the sender; while, by the Morse system, there is an opportunity for mistakes at each end of the line.

THE Director of the Batavia Observatory, Dr. Van der Stok, has published the monthly and yearly rainfall values of the East Indian Archipelago for 1897—the nineteenth year of the series. The stations number 215; in Java the rainfall of the year was less than the average, but in Sumatra the amount was greater than the mean, especially during the first part of the year. One of the tables shows the greatest quantity of rain in twenty-four hours during each month, for the years 1879–97; at Batavia and several other places the fall amounted to over 11 inches, and in the south of the island of Saparoea to nearly 16 inches.

PROF. L. ERRERA, of Brussels, reprints from the *Bulletin* of the Royal Academy of Belgium an account of experiments made on *Aspergillus niger*, which he claims to prove indisputably that an acquired character—viz. adaptation to the medium in which it grows—is transmitted by inheritance.

THE part of the *Minnesota Botanical Studies* for February is full of interesting matter. Besides papers of more local interest, are articles on seedlings of certain woody plants, and on the comparative anatomy of hypocotyl and epicotyl in woody plants, by Mr. F. Ramaley; a contribution to the life-history of *Rumex*, by Mr. Bruce Fink; one on seed dissemination and distribution of *Razoumofskia robusta*, a parasitic plant belonging to the Loranthaceæ, by Prof. D. T. MacDougal; also observations on *Gigartina*, by Mary E. Olson, and on *Constantinea*, by Mr. E. M. Freeman.

PROF. F. PLATEAU, of Ghent, pursues his adverse criticism of the theory that insects are mainly attracted to flowers by the sense of sight in their capacity as pollen-distributors. In a paper, reprinted from the Memoirs of the Zoological Society of France, he details a series of observations on *Salvia horminum* and *Hydrangea opuloides*. Neither the coloured bracts of the former, nor the conspicuous sterile flowers in the latter species, can be regarded as "vexillary." In both

cases the pollinating insects make their way at once to the flowers which contain the honey, without being visibly guided by the showy organs in either case; while, if these are removed, it does not appear to make any material difference in the number of insects which visit the inflorescence.

The conception of vast magnitudes forms the basis of two papers in *Die Natur* for April, by H. Sonnenschmidt, entitled "A Glance at the Kingdom of Large Numbers."

"Mosquitos and Malaria" form the basis of an article by Dr. F. Mesnil, in the *Revue générale des Sciences*, on the hæmatozoa of marsh fevers. The paper is illustrated by figures showing the different stages of the hæmatozoa both of man and of birds.

In two papers communicated to the *Verhandlungen* of the German Physical Society, C. Liebenow applies the principles of thermodynamics to calculate the thermo-electromotive force of metal conductors, and compares the results of theory and experiment.

The Horseless Age, a New York journal devoted to the interest of the motor vehicle industry, is now, at the beginning of its fourth year, issued weekly instead of monthly. The first number of the new volume contains a paper by Mr. Hudson Maxim, on "Some thermodynamics of vehicle motors," and an editorial discussion on the question "Shall vehicle motormen be licensed?"

An extension of the methods of integration of Monge and Ampère is worked out by G. Vivanti in the *Rendiconti del R. Istituto Lombardo*, xxxii. 6. The present paper contains a generalisation for any number of variables of certain investigations of the types of partial differential equations of the second order which satisfy conditions of integrability, the corresponding system of conditions in the case of three variables having been investigated previously by Vivanti, whose results have been generalised by Forsyth.

In a communication to the *Bulletin* of the Cracow Academy, No. 2, M. K. Zorawski applies the method of conformal representation to the convergency of Lagrange's, Bürmann's, Hoene-Wronski's, and other series derivable from Taylor's theorem. The same writer also discusses the geometry of certain infinitesimal transformations and differential expressions which do not possess the property of remaining invariable under the given transformations. This number of the *Bulletin* also contains papers by S. Kepinski on the integrals of solutions of certain equations of the second order with three singular points.

In *Terrestrial Magnetism* for March 1899, Dr. L. A. Bauer gives two papers, one on the physical decomposition of the earth's permanent magnetic field, and the other a preliminary note on the question, "Is the principal source of the secular variation of the earth's magnetism within or without the earth's crust?" The object of the first paper is to resolve the earth's so-called permanent field into component ones physically interpretable. In it the author arrives at the somewhat striking conclusion that the unsymmetrical distribution of the earth's magnetism, and the unsymmetrical distribution of temperature as exhibited on the earth's surface, on the average for the year, are in some way related to each other.

Prof. H. Poincaré, writing in the *Revue générale des Sciences*, deals with certain considerations connected with the theory of probability. The author, from consideration of various problems, points out that in all probability calculations it is necessary to take as starting-point some hypothesis or convention which is always to a certain degree arbitrary. The most frequent hypothesis is the doctrine of continuity, and the most satisfactory calculations are those in which the result is independent of the hypothesis made at the commencement, provided that this hypothesis satisfies the conditions of continuity.

Dr. H. J. Oosting, writing in the *Zeitschrift für den physikalischen und chemischen Unterricht*, describes several contrivances for exhibiting the resultant of two circular or elliptic vibrations of different periods. In these a beam of light is reflected in succession from two mirrors, which are made to rotate about axes nearly but not quite perpendicular to their planes, the two rotating systems being connected by cogged wheels or an endless band, by which the ratio of the periods of rotation is defined, and the path of the resultant motion is shown by allowing the doubly-reflected beam to fall on a screen. The curves produced by composition of *two* circular or elliptic motions could be drawn by a much simpler apparatus, consisting essentially of a jointed pendulum capable of vibrating in all directions; but we would suggest that Dr. Oosting's method might be applied to tracing the various forms obtained by compounding *three* or more circular motions whose periods are in the ratio of different whole numbers.

Slowly but surely the photographic film is taking the place of the glass plate for many purposes, and its introduction now into the physical and astronomical laboratory is an important indication of its progress. Being light and flexible, and as sensitive and durable as glass plates, the two first-named properties render it of great service where weight and curved fields have to be dealt with. To determine the value of films where it is difficult to use the ordinary glass plate, Sir Norman Lockyer has lately been experimenting, and very successfully, with them, with the idea of adapting them to spectroscopic photography. The large concave Rowland grating now in use for solar spectroscopic photographs, has 20,000 lines to the inch ruled on its surface, and is of 21½ feet radius, giving a spectrum of 30 inches long. The focal plane of this grating is of necessity considerably curved; in fact, the plane of accurate definition at the edges of the field is about 0·5 inch in front of the similar plane at the centre. It is, therefore, impossible to get a sharp photograph of the whole spectrum on a glass plate; in fact, not more than 18 to 20 inches of the spectrum can be brought into focus on the same plane. This difficulty is, of course, got over by the use of a flexible film, which can be bent to the curvature of the field. The Kodak Company have sent us a print of one of Sir Norman's photographs taken with this Rowland concave grating. It is 30 inches long, and shows the arc spectrum of iron with a comparison spectrum of the sun from wave-length 3600 to 5200, and the lines are beautifully sharp from one end to the other. Sir Norman Lockyer also hopes that by using films, instead of glass plates, at the next solar eclipse, he will be able to obtain a greatly increased number of photographs, owing to the rapidity with which the film can be shifted in the short space of time available for photographic operations. At the last eclipse the photographic work was concentrated on obtaining a series of photographs of the chromosphere, both about the time of beginning and end of totality. By careful drill Mr. Fowler and Dr. W. J. S. Lockyer were both able to secure ten photographs at each of these important periods, the time occupied in making each series of ten exposures being twelve seconds. An apparatus for carrying films is also being designed, which can be adapted to the spectroscopic cameras at present in use in the laboratory and observatory.

At the recent meeting of the Institution of Mining Engineers, the use of high-pressure steam as a possible substitute for gunpowder or other dangerous explosives in coal mining was suggested by Major-General H. Schaw, C.B. Broadly, the suggestion is that a cartridge of pure water lodged in a shot-hole

should be converted into steam at about 150 pounds per square inch pressure by means of electricity of low tension; the cartridge or boiler to be made of such strength that it would burst at about this pressure, when the force set at liberty would break down the coal. As an approximation, Major-General Schaw points out that a water-cartridge $1\frac{3}{4}$ inches in diameter and $3\frac{1}{2}$ inches long, to be used in a 2-inch blast-hole, would hold about 8·4 cubic inches of water. It would be converted into high-pressure steam, and burst the cartridge in about one minute with the electrical power which the author suggests, and would thus exert a sudden force of about $1\frac{1}{4}$ tons. The calculations which the author has made on the subject, and a sketch of a form of cartridge which embodies the principles of the suggestion, accompany the paper.

A LEAFLET, prepared and issued by Mr. John Plummer, Sydney, New South Wales, brings together a number of interesting facts referring to Australian birds. Although Australia has no native song birds like the nightingale, lark, thrush, or linnet, it possesses a great variety of feathered species, several of great beauty, and many possessing features of interest. Many birds known in Europe are plentiful in New South Wales. Among these are eagles, hawks, owls, swifts, swallows, martins, fly-catchers, pelicans, sand-pipers, plovers, ducks, grebes, petrels, gulls, terns, penguins, and albatrosses. The number of ducks on the inland rivers and lagoons is at times surprising. The Rev. J. E. Tenison Woods says he has travelled in winter along the river Murray, and the long estuary of the Coorong, and for upwards of 120 miles was never out of sight of large flocks, which literally darkened the air and water. The sparrow, as in other countries, is the pest of the farm and orchard in New South Wales. So long as there is plenty of seed and fruit the bird does not trouble itself about insects, but leaves it to its insectivorous brethren. Every kind of British cage-bird thrives in the colony, but when liberated they often have to fight for existence with the native species.

MESSRS. SWAN SONNENSCHEIN AND CO. announce the forthcoming publication of "Curiosities of Light and Sight," by Mr. Shelford Bidwell, F.R.S.

DURING May the following lectures will be given on Tuesday evenings at the Royal Victoria Hall, Waterloo Road, S.E.:—May 2, Mr. E. S. Prior, "The Art and Practice of Garden-making"; May 9, Mr. R. Kerr, "Picturesque Ireland"; May 16, Prof. Beare, "Curiosities of Insect Life."

SOME members of the Avicultural Society are organising a Postal Club for the encouragement of bird and animal photography. The co-operation of photographer-naturalists is invited. Address Mr. Chas. Louis Hett, hon. secretary *pro tem.*, Springfield, Brigg.

MESSRS. DUCKWORTH AND CO. are about to publish a book on natural selection, by Mr. Frederick Wollaston Hutton, F.R.S., entitled "Darwinism and Lamarckism." The object of the work is to give a concise account of the origin and growth of the Darwinian doctrine, including its most recent developments.

THE inspiring "Hunterian Oration" recently delivered at the Royal College of Surgeons of England, by Sir William MacCormac, Bart., K.C.V.O., has been published in volume form by Messrs. Smith, Elder, and Co. An abstract of the address has already appeared in these columns (p. 402); but every student of medical science should read the address in full, in order to understand the influence of Hunter's work upon modern surgery.

MESSRS. R. AND R. BECK, LTD., have issued a new catalogue of the Frena hand camera, and will send a copy to any one on application. The good qualities of the Frena are known to many photographers, and the selection of pictures in the catalogue shows that fine results can be obtained with this form of camera.

AN illustrated international monthly magazine of photography, published in four languages, and entitled *Camera Obscura*, will make its appearance in June. The magazine will be under the chief editorship of J. R. A. Schouten, the assistant editors being: French Section, Maurice Bucquet; German Section, R. Ed. Liesegang; English Section, Max Sterling; Dutch Section, Chr. J. Schuver. The publishers will be Messrs. Binger Bros., Amsterdam; and the publishers for Great Britain and the Colonies, Messrs. Williams and Norgate.

AMONG the new features of the 1899 edition of "The Statesman's Year-Book" (Macmillan), edited by Dr. J. Scott Keltie, with the assistance of Mr. I. P. A. Renwick, are a map of Africa showing railways, navigable waters, and distances from coast, and one showing telegraphs and political divisions; a map of Newfoundland, illustrating the French shore question; and a map showing the addition on the Chinese mainland to the colony of Hong Kong. There are also preliminary tables showing the revenue, expenditure, debt, and debt-charge of the principal countries of the world, with the commerce of these countries in figures and per head of population; and a table showing the gold and silver production of the world. The events of the past year have necessitated a number of alterations, and the additions have increased the volume from 1166 to 1248 pages. No one interested in political geography can dispense with this annual statement of the position of the countries of the world.

MM. GEORGES CARRÉ AND C. NAUD, Paris, have commenced the publication, under the general title "Scientia," of a handy collection of monographs, by distinguished investigators, on important scientific questions. The collection is divided into two series, one containing papers on physical science, and published under the direction of MM. Appell, Cornu, d'Arsonval, Friedel, Lippmann, Moissan, Poincaré, and Potier; and another series containing biological papers edited by MM. Balbiani, d'Arsonval, Filhol, Fouqué, Gaudry, Guignard, Marey, and Milne-Edwards. In the first volume of the physical series, M. Poincaré gives a simple account of Maxwell's theory and Hertzian oscillations. In the first volume of the biological series, Prof. Bard deals with "La spécificité cellulaire," referring particularly to the consequences of this doctrine in biology. The second volume in this series, by Dr. F. le Dantec, is on sexuality. Only these three volumes have so far appeared, but a number of others are in preparation, and will shortly be published. Each volume will be complete in itself, and the complete set of monographs will make a convenient library of modern scientific work and opinion.

THE additions to the Zoological Society's Gardens during the past week include two Himalayan Monauls (*Lophophorus impeyanus*, 2 ♂) from the Himalaya Mountains, presented by Mrs. Barnewell Elliot: a Black-shouldered Kite (*Elanus caeruleus*) from Ceylon, presented by Mr. J. D. Waley; a Macaque Monkey (*Macacus cynomolgus*, var.) from India, a Brazilian Tapir (*Tapirus americanus*, ♂) from Peru, a Great Bustard (*Otis tarda*), European; three Anoas (*Anoa depressicornis*, ♂ ♂ ♀) from the Celebes, deposited; two Brush Turkeys (*Talegalla lathami*), three Pectoral Quails (*Coturnix pectoralis*), a Varied Hemipode (*Turnix varia*) from Australia, two green Glossy Starlings (*Lamprocolius chalybeus*) from North-east Africa, two White-backed Trumpeters (*Psophia leucoptera*) from the Upper Amazons, purchased; five Barbary White Sheep (*Ovis tragelaphus*, 2 ♂, 3 ♀), a Yellow-whiskered Lemur (*Lemur xanthomystax*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in May:—

May 2-6. Meteoric shower before sunrise from Aquarius.
4. Tuttle's comet in perihelion.
8. 11h. 6m. Minimum of Algol (β Persei).
13. 8h. 47m. to 10h. 12m. Transit of Jupiter's Sat. III.
16. Swift's comet closely S.W. of *o* Andromedæ (mag. 3·8).
20. 12h. 5m. to 13h. 36m. Transit of Jupiter's Sat. III.
24. 10h. 15m. to 11h. 25m. Occultation of B.A.C. 5254 (mag. 5·4) by the moon.
26. 11h. 39m. to 12h. 39m. Occultation of 7 Sagittarii (mag. 5·4) by the moon.
26. 12h. 3m. to 13h. 15m. Occultation of 9 Sagittarii (mag. 5·7) by the moon.
27. 2h. Uranus in opposition to the sun.

Tuttle's Comet (1899 *b*).—The following positions are continued from the ephemeris by Herr J. Rahts in *Astr. Nach.* (Bd. 149, No. 3555):—

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″	Br.
April 27	4 32 53·4	+13 27 35	1·86
28	36 20·6	12 59 33	
29	39 47·2	12 31 20	
30	43 13·3	12 2 56	1·89
May 1	46 38·9	11 34 21	
2	50 4 0	11 5 35	
3	53 28·8	10 36 39	
4	4 56 53·1	+10 7 33	1·90

Tempel's Comet (1873 II.).—The following search ephemeris is given by M. L. Schulhof in *Ast. Nach.* (Bd. 149, No. 3554):—

Ephemeris for 12h. Paris Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″	Br.
April 27	18 36 50·4	− 5 13 22	0·370
28	38 35·2	5 8 45	
29	40 19·6	5 4 11	
30	42 3·8	4 59 39	0·405
May 1	43 47·6	4 55 11	
2	45 31·1	4 50 46	
3	47 14·2	4 46 25	
4	18 48 57·0	− 4 42 8	0·460

Double-star Catalogue.—*Ast. Nach.* (Bd. 149, Nos. 3557 and 3558) contain a catalogue of 132 new double-stars which have been discovered by Prof. G. W. Hough, with the 18½-inch refractor of the Dearborn Observatory, Illinois, U.S.A. This is the fourth catalogue of new double-stars issued from the same observatory, the total number now reaching 622. The measures have been made during the period 1894 to 1897, each pair having been measured on two or more nights. Magnifying powers of 390 and 925 have been most frequently employed. It is noted that one of the stars, No. 580 in the catalogue, is probably a binary, successive measures having indicated motion between the components. This star is Lalande 37881, and its position for 1880 is R.A. 19h. 47m. 19s.; Decl. + 22° 9′. The change of position angle, on which the probability of its being a binary is based, is shown in the following table:—

Date.	Position angle.	Distance.	Magnitudes.
1895·76	267·6	0″·65	8 ... 8·1
1897·62	276·0	0″·68	8 ... 8·2

Law of Temperature in Gaseous Bodies.—The *Astronomical Journal* (No. 459) contains some further criticisms on Dr. See's article on "The Sun's Heat" (*A. J.*, No. 455) by Mr. C. M. Woodward, of Washington University. The points he brings forward are as follows:—

(1) Dr. See assumed his hypothetical gaseous globe to have a definite boundary, but there is no good reason to suppose that a pure gas, unrestrained save by the mutual attraction of its particles, has a definite limiting surface.

(2) The assumption that the *pressure* at R_0 is directly measured by the weight of an element of mass is wrong; it is the *variation* in the pressure which is measured by the weight.

(3) Instead of the intensity of pressure varying *inversely* as the fourth power of the radius, as given by Dr. See, it really varies inversely as the square, or $P = \frac{A}{R^2}$.

(4) The final derivation of the formula $T = \frac{K}{R}$ is false, because the value of P, by which it is determined, is wrong. "Dr. See appears to forget that when the volume of a given gas is fixed by other considerations, the pressure is independent of the force of gravity. He leaves the question of temperature still unsolved. Instead of finding the temperature from the pressure, the temperature is to be determined by the principle that the change of temperature during contraction must be such as to render the force of mutual attraction sufficient to do the work of compression. For a solution of that problem, I beg leave to refer to my paper read before the Saint Louis Academy of Science, March 20, 1899."

Return of Holmes' Comet (1892 III.).—Mr. H. J. Zwiers gives in *Ast. Nach.* (Bd. 149, No. 3553) a detailed ephemeris for the expected return of this comet, which he calculates will pass perihelion on April 27. This not being quite certain, he also gives the positions corresponding to perihelion passages on April 19 and May 5. We append the positions for T = April 27·6651:—

Ephemeris for 12h. G.M.T.

1899.	R.A. h. m. s.	Decl. ° ′ ″	Br.
April 28	23 59 25·3	+ 4 0 15	0·0272
30	0 3 0·8	4 37 29	
May 2	6 35·7	5 14 44	
4	10 10·1	5 52 1	0·0280
6	13 43·8	6 29 19	
8	17 17·0	7 6 37	
10	20 49·5	7 43 54	
12	24 21·4	8 21 11	0·0290
14	27 52·7	8 58 25	
16	31 23·3	9 35 39	
18	0 34 53·2	+10 12 50	0·0298

THE THEORY OF THE RAINBOW.

Most text-books still explain the rainbow phenomena with the aid of Descartes' "effective" rays. This explanation concerns only the principal and the secondary bows; it does not take notice of the supplementary bows, nor of the fact that the colours, their intensity, breadth, and sequence vary greatly with the size of the raindrops. That the rainbows are interference phenomena, was recognised by Young. Their correct theory is contained in Airy's "Intensity of Light in the Neighbourhood of a Caustic" (*Trans. Cam. Phil. Soc.*, vi. p. 379; viii. p. 595, 1838 and 1848). The intensity depends upon an infinite integral, which Airy first attempted to compute by quadratures. Stokes found a more convenient form for his integral. The theory was first verified by W. Hallows Miller in 1871; later by Boitel, Mascart, and others. In 1896, Prof. J. M. Pernter, then at Innsbruck, now director of the Central Station for Meteorology and Earth Magnetism at Vienna, presented a long paper on the colours of the rainbow and the white rainbow to the Vienna Academy (*Wien. Akad. Ber.*, 106, ii. *a*, p. 137, 1897). The paper involved very laborious calculations and experiments, and dealt fully with the influence of the size of the raindrops; it was referred to in Nature, January 27, 1898. In the Jubilee number of the *Zeitschrift fur Oesterreichische Gymnasien*, December 1898, Pernter has now made an attempt to render Airy's theory intelligible to the pupils of secondary schools.

The importance of the angle of minimum deviation is explained with the help of the diagram (Fig. 1). Not to complicate the figure, the rays are all supposed to correspond approximately to Fraunhofer's line C in the red-orange. With increasing angle of incidence, the deflection of the refracted ray from its original direction becomes greater and greater, until a maximum is reached (the dotted ray); on further increasing the angle of incidence, the deviation decreases again.

That this is so, is shown in tables giving angles of incidence, refraction, and the resulting final deviation, and is further explained by a simple trigonometrical deduction. The reflected and refracted rays emerge, not parallel to one another, but divergent or convergent. The limiting ray of minimum deviation, and the rays in its immediate neighbourhood and approximately parallel to it, would be the "efficient" rays of Descartes. They have their significance, though not that which Descartes ascribed to them. For the C rays, this angle (which corresponds to an angle of incidence of 59° 24′) is 42° 4′; that is to say, the red-orange arc of the primary bow is seen under that angle. Multiple reflection within the raindrops renders an infinite number of other such limiting rays possible. The emerging rays would emanate from various quadrants. We should hence see bows, not only when standing with our backs to the sun, but also when a cloud is between our eyes and the sun (*e.g.* in the case of three and four internal reflections). The direct sunlight would prevent our seeing those bows, but they can be observed and shown in class-rooms when we let the light fall on cylindrical glass rods after Babinet's fashion. With cylinders instead of spherical drops, we see, of course, a series of vertical coloured bands, arranged in a horizontal line, instead of arcs. Miller, experimenting with water streams, measured thirty such monochromatic bands. Pernter describes a simpler arrangement, and calculates, in his popular treatise, the angles of minimum deviation for fifteen bows, both for water and glass. Experimenting with white light and water streams, 1 mm. and less in diameter, he counted with 1 mm. drops one bow and twenty-four secondaries (supplementary bows) of beautiful colours (white in the twelfth, after which the sequence of the colours is reversed), and with drops of 0·5 mm. eleven bows and secondaries and some more bands of indistinct colour (white in the fifth).

We recognise from Fig. 1 that the emerging wave has not a straight front like the entering spherical wave AB, but a peculiarly curved front, represented in exaggerated curvature in Fig. 1*a*. Such a wave must give rise to interference phenomena, and all the rainbows, not only the supplementary (or so-called spurious) bows, are really diffraction phenomena of a peculiar kind. That part of the wave-front which is nearest to the ray of minimum deviation might be called the effective wave-front. In order to arrive at an equation for that part, Pernter starts from Wirtinger's consideration that, if s_1, s_2, and s_3 are the paths of a ray, in the air, in the water and again in the air, reckoned between the entering and the emerging wave-fronts, and c_1 and c_2 the velocities of light in air and in water, then $\frac{s_1}{c_1} + \frac{s_2}{c_2} + \frac{s_3}{c_1} =$ const. for all rays of that wave. The constant can be chosen at will; he takes the value $\frac{a}{c_1}$, in which a is the radius of the drop. Under the assumption that the curve consists of two spherical arcs, one concave, the other convex, Pernter then calculates the phase difference after Mascart. As regards the amplitude, however, of his intensity equation, he has to refer back to Airy; but he succeeds in showing that each colour of the rainbow consists of an infinite number of coloured rings of decreasing intensity, separated by rings of intensity 0. Pernter objects to the term "spurious" rainbows, since they are as much rainbows as the ordinary bows; his own terms, Hauptbogen, Nebenbogen, secundäre Bogen (principal bow, by-bow, secondary bows) are not suitable for literal translation. When we replace the prism of a spectroscope by a glass rod, 2 mm. in diameter, and set the telescope under 22° 51′ (principal bow for glass), we see a series of red bands as mentioned. If this angle is not convenient, we adjust the instrument for one of the other bows. The first is by far the brightest; after the eighth maximum the intensity diminishes very slowly; Airy's original curve brings this out very clearly. Replacing the rod by one, less than 1 mm. in diameter, we notice that the colours are different and less bright; the blue, absent in the first experiment, is prominent, and all the bands are broader than before. Smaller raindrops give broader bows, but, owing to their diminished intensity, their number appears smaller. Fig. 2 is Pernter's colour curve for raindrops 0·5 mm. in diameter. The size of the actual raindrops lies, for our latitudes, between 0·05 and 2 or 3 mm. diameter. The fog-bow is produced by the sun when shining on the water globules, 0·05 mm. and less in diameter, of fine mists. We notice that we get real white in the bow by superposition of the colours. This is possible for drops of all sizes, and must occur with very small drops. The sequence of the fog-bow colours is: very faint yellow, whitish yellow, bright white, whitish violet; colourless gap; then (secondary bows) faint whitish blue, white, whitish red. To imitate these mists, Pernter fixed a glass tube, 0·5 mm. in diameter, in a lead pipe connected with the high-pressure water mains, and directed the jet against a metallic plate; the mist thus produced consisted of drops 0·0106 mm. in diameter. McConnel (*Phil. Mag.*, 29, p. 453, 1890), who made calculations for raindrops of certain sizes in 1890, describes eighteen fog-bows, observed by Osmond in 1886–87 on Ben Nevis; of these, ten were double. Exact measurements of rainbows are exceedingly scarce. Pernter differs from McConnel as regards the border colours of fog-bows; he also doubts that the pale colour of fog-bows can be due to the uneven sizes of the drops, because the accompanying phenomena, glories, require homogeneous conditions. But dilution with white light, of course, makes all colours appear whitish.

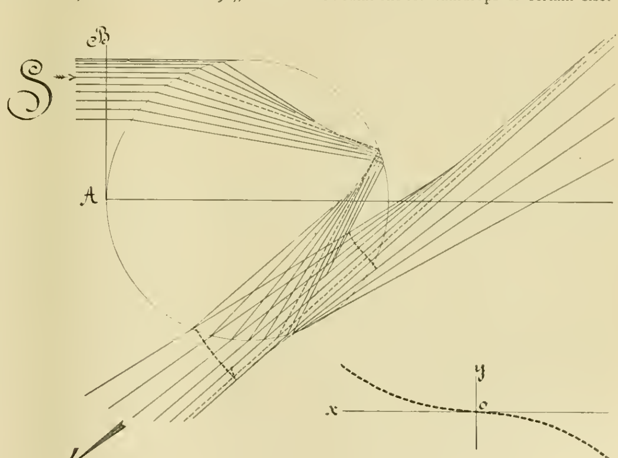


Fig 1. Fig. 1*a*.

Pernter's conclusions are interesting to meteorologists. The greater the drops, the more secondary bows. Bright pink and green, without blue, indicate drops from 1 to 2 mm. in diameter; intense red occurs with big drops only, but the maximum intensity is really in the violet. Drops of 0·5 mm. give secondaries consisting of green and violet (and also blue, which, however, is masked by contrast) immediately joining the principal bow. Yellow in the secondary would mean drops of 0·3 mm. and, if there are separating gaps, of 0·2 mm. Drops of diameters between 0·17 and 0·4 mm. show the greatest variety of colours, also in the secondary bows; but real red is absent. When we notice five and more secondaries of striking breadth

without white and without gaps, we have probably drops of 0·1 mm.; in smaller drops, gaps and white make their appearance. A real white bow with yellow or orange and blue margins requires drops of not more than 0·05 mm. Moonbows appear white owing to their feeble intensity. A small change in the size of big drops does not much matter. These

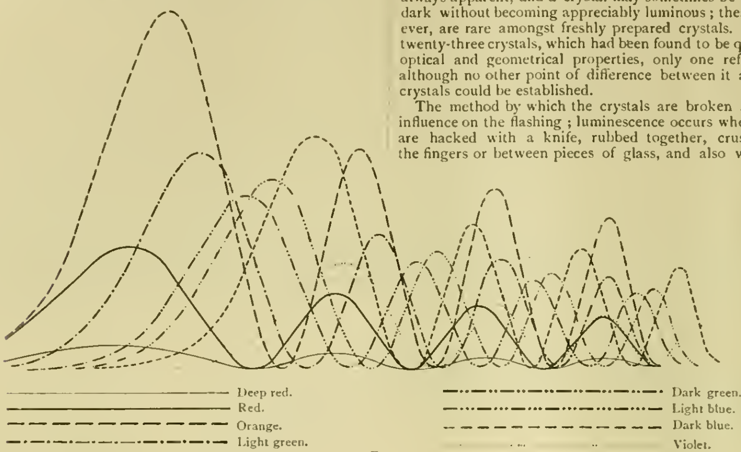


FIG. 2.

statements are based upon calculations and laboratory experiments; a confirmation by actual observations is hardly possible, since we cannot measure the size of the raindrops that produce the rainbows whose colours we are studying. H. B.

ON TRIBOLUMINESCENCE.

THE name triboluminescence has been applied by E. Wiedemann to an emission of light not due to rise of temperature which occurs on crushing certain substances.

It has long been known that on tearing cleavage sheets of mica apart, or on crushing crystals of cane sugar, light is given out; and during the last few months attention has again been drawn to this curious phenomenon by a paper read before the British Association by Mr. J. Burke, on the luminosity produced by striking sugar crystals (NATURE, vol. lviii. p. 533), and by Mr. T. Steel's letter to NATURE (vol. lix. p. 295) on the same subject. A brief account of other work done on the subject of triboluminescence during recent years may therefore be of interest.

Some years ago I contributed a paper to the Chemical Society (*Trans. Chem. Soc.*, 1895, 985) on orthobenzoicsulphinide $C_6H_4\left\langle\begin{array}{c}SO_2\\CO\end{array}\right\rangle NH$, the substance known commonly as saccharin, and which is now largely used as a substitute for sugar when the use of the latter is considered undesirable upon medical or other grounds. I showed that commercial saccharin crystallises, on spontaneous evaporation of its solution in acetone, in large, transparent, monosymmetric crystals having the geometrical constants:—$a : b : c = 2·7867 : 1 : 1·7187$, $\beta = 76° 8' 30''$. On breaking or crushing the freshly prepared crystals, they emit a very vivid, bluish-white light, which, however, is only of momentary duration. This flashing or phosphorescence of the crystals is very brilliant, and is quite noticeable even in a well-illuminated room. The luminescence was, in fact, first noticed whilst the crystals were being manipulated in the full glare of an incandescent gas lamp. The phosphorescence may be well shown on a small scale by pulverising a crystal between two microscope slides, and on a larger scale by vigorously shaking a bottle of the crystals in a dark room; on grinding a quantity of the material in a glass mortar in the dark, an almost continuous, though rather fainter, luminescence is observed. On closely watching large transparent crystals whilst crushing them, the illumination appears to consist of a glow which pervades the whole crystal just as it breaks, and then immediately disappears; the emission of light consequently occupies so short a time as to appear instantaneous. The luminescence is not always apparent, and a crystal may sometimes be crushed in the dark without becoming appreciably luminous; these cases, however, are rare amongst freshly prepared crystals. On crushing twenty-three crystals, which had been found to be quite normal in optical and geometrical properties, only one refused to flash, although no other point of difference between it and the other crystals could be established.

The method by which the crystals are broken seems without influence on the flashing; luminescence occurs when the crystals are hacked with a knife, rubbed together, crushed between the fingers or between pieces of glass, and also when they are caused to crack by rapid heating, either in the air or in the acetone mother liquor from which they crystallise. There seems to be no particular plane in the crystal parallel to which breaking occurs without luminescence; no matter how carefully a crystal is cleaved along the very perfect cleavage on the pinacoid {100}, so that parting only occurs parallel to the cleavage plane, and with a minimum of shock, vivid luminescence always occurs; and on carefully cutting the crystals in directions perpendicular to the cleavage, so that very little parting occurs along this plane, a brilliant flash almost invariably results.

An exhaustive examination of the properties of the crystals was made, in order to allow of some cause being assigned to this peculiar phenomenon; it was at first thought that the crystals might be hemimorphic or hemihedral, and that the luminescence might be in some way related to the polar properties inseparable from hemimorphism. No positive evidence was, however, obtained in this direction.

Crystals of orthobenzoicsulphinide, obtained by other methods than the above, showed no triboluminescence. The substance on heating sublimes in long glistening needles, which are morphologically and optically identical with the crystals deposited from acetone, but show no triboluminescence.

After the publication of the paper referred to, Luigi Brugnatelli (*Zeits. f. Krystallographie*, 1897, **27**, 78) gave particulars of several similar cases found by him amongst derivatives of santonin prepared by Amerigo Andreocci (*Atti d. R. Accad. Linc.*, 1895, [5*a*], **2**, 28). The monosymmetric crystals of ethylisodesmotroposantonin, $C_{12}H_{13}(OEt)\left\langle\begin{array}{l}O.C:O\\ \quad\;\; |\\ -CHMe\end{array}\right.$, emit a yellow luminescence when crushed; the monosymmetric crystals of the enantiomorphously related dextro- and lævo-ethylic santonite, $C_{12}H_{14}(OH)CHMe.COOEt$, and the monosymmetric crystals of lævodesmotroposantonous acid, $C_{12}H_{14}(OH)CHMe.COOH$, all give a yellowish-green triboluminescence. Lævoethyldesmotroposantonous acid $C_{12}H_{14}(OEt)CHMe.COOH$, crystallises in hemihedral anorthic crystals, which when crushed glow with a beautiful emerald-green light.

Crystals of saccharin have also been examined by W. Arnold (*Zeits. f. Kryst.*, 1896, **27**, 92), who describes their triboluminescence as "stark," and states that that of crystallised hippuric acid $C_6H_5.CO.NH.CH_2.COOH$, is "sehr stark."

Since the publication of my paper in 1895, I have made a few observations of interest to which I may now refer. Crystals of saccharin which, when freshly prepared, flash brilliantly on crushing, gradually lose this property, and after a few weeks' preservation show no appreciable triboluminescence. Further, in order to obtain crystals which exhibit a brilliant triboluminescence, the impure commercial saccharin must be crystallised from acetone; a carefully purified specimen of saccharin, when crystallised from acetone, yielded crystals which do not phosphoresce at all when broken. Both of these points are of great importance as affording possible clues to the cause of this strange property; it would be of interest to ascertain whether the triboluminescence of cane sugar, hippuric acid, and other substances is in any way characteristic of the freshly prepared crystals, and is dependent on the presence of traces of impurity. Another point of great interest, indicating that triboluminescence is probably not a property of the chemical molecules, but only of the crystalline structure, is noted in Brugnatelli's paper; although the crystals of dextro- and lævo-ethylic santonite show brilliant triboluminescence, the anorthic crystals of the racemic compound of these two substances exhibit no triboluminescence.

In concluding this note on triboluminescence, may I point out that the study of the subject from a physical standpoint should be extremely fertile. Saccharin may now, thanks to commercial enterprise, be obtained in large quantities at a comparatively low cost.

WILLIAM JACKSON POPE.

EXPLOSIONS CAUSED BY COMMONLY OCCURRING SUBSTANCES.

THE occurrence of a serious explosion in the Capitol at Washington, last November, has led the President of the American Society, Prof. C. E. Munroe, to address the members on the subject of explosions caused by commonly occurring substances. The address, which is fully reported in a recent number of *Science*, forms an interesting and valuable history of the subject, beginning with the well-known flour mills explosion in Glasgow in 1872. A similar explosion in Minneapolis, in 1878, shattered walls six feet thick at the base, and projected sheets of corrugated iron to a distance of more than two miles. The origin of the explosion was traced to the striking of fire by a pair of mill-stones through the stopping of the "feed." Dust explosions have also been recorded in connection with oatmeal, starch, rice, malt, spice, saw-dust, soap and zinc. In pharmacy and the arts accidents have arisen from various mixtures of combustible substances and oxidising agents in connection with matches, chlorate of potash lozenges, sodium peroxide and sodium bisulphite mixtures. Among substances explosive *per se* which have given rise to accidents, are erythryl nitrate, ammonium nitrate, and various nitroso compounds, diazo bodies, diamides, hydrazoic acid and its compounds, hydroxylamines, chlorates, carbonyl compounds, permanganates, peroxides, chlorides and iodides. Prof. Munroe devotes a considerable amount of space to explosions arising from the use and storage of petroleum, drawing his information mainly from English sources. He adds to the examples, well known in connection with British shipping, of explosions caused by the use of "driers" and paints made up with volatile hydrocarbons. A remarkable explosion occurred at Rochester, New York, in 1887, owing to the leakage of twelve thousand gallons of naphtha from a dislocated iron main into a sewer. The explosive mixture of air and vapour was ignited from a boiler fire through an untrapped water-closet, and the explosion, besides causing loss of life, destroyed three large mills. Prof. Munroe states that of substances supposed to impart safety to kerosene, alum and sal-ammoniac are practically insoluble in the liquid, and are of no effect; whilst camphor, though it raises the flash-point, causes the vapour mixed with air to have a lower temperature of ignition.

After dealing with compressed gases and coal-dust explosions, Prof. Munroe reverts to the Washington explosion, and shows that it was due primarily to the escape of gas through a governor into a "live" 4-inch main, owing to a sudden doubling of pressure. The gas found its way through a labyrinth of passages and compartments in a section of the building, and when the stratum of gas reached down to the level of some burning gas jets, ignition took place and the explosion was propagated in all directions, its intensity and range being increased by the disturbance of large accumulations of inflammable dust.

TECHNICAL EDUCATION IN GERMANY.[1]

GERMAN merchants and manufacturers are alive to the importance of increasing the efficiency of the mechanics and artisans, and of improving the quality of their goods. According to the United States Consul at Hanover, they appear to be resolved that "Made in Germany" shall no longer pass as a term of opprobrium, but be a synonym of excellent materials and good workmanship. A meeting took place recently in Hanover, which is likely to exercise a very important influence in this direction. It was in the nature of a conference, under Governmental sanction and direction, to discuss German trade and manufacturing interests, and to devise plans for their extension and improvement. It was held at the instance of the Prussian Minister of Trade and Commerce, and was presided over by the Oberregierungs President of the Province of Hanover, Count Stolberg Representatives of the Government from Berlin, the highest officials of the Hanoverian provincial and municipal administrations, leading manufacturers and business men, delegates from the Chamber of Commerce, the manual training and artistic trade schools, and from the working men's trade unions, attended and took part in the deliberations. As a result of the conference, it was unanimously resolved: (1) To establish at once in the city of Hanover advanced lecture courses, in which artisans and apprentices in all trades shall have an opportunity to complete their mechanical education, and be instructed by experts how to install and manage a model workshop, and work and use machines and tools to the greatest advantage. Instruction will also be given in book-keeping, the making and rendering of accounts, the making of estimates of the cost of work and materials, how to conduct business correspondence, drawing, and other practical branches. (2) The supervision and control of the said lecture courses shall be under the direction of a commission composed of representatives from the Imperial, provincial, and municipal administrations, the Chamber of Commerce, the manual and art schools, and from the trade unions. (3) The first course of lectures will be for cabinet-makers, locksmiths, shoemakers and tailors. Those for other trades will follow. (4) A fee for tuition will be exacted from mechanics able to pay, but those unable to pay will be instructed free. Funds for the payment of the tuition of the poor will be provided by the Hanover provincial and municipal Governments. (5) Only mechanics and apprentices will be admitted to the classes whose theoretical and practical knowledge is such as to give promise of success as students. The Commission has power in all cases to decide as to qualification of applicants for admission. (6) Teachers are to be selected by the Commission, and confirmed by the Minister of Trade and Commerce. (7) The cost of the establishment and maintenance of the lectures is to be supplied by the General Government, and that of the province and city of Hanover, together with the trades unions, the Chamber of Commerce, and others interested therein. (8) It is further intended that great care shall be used in teaching apprentices how to obtain the most practical advantages from the knowledge obtained by them in the classes. To this end, the creation of working-men's co-operative societies is to be urged. (9) A permanent exhibition of all power machines and tools used in the small trades is to be established in the Gewerte Halle (Industrial Hall) in Hanover. The machines exhibited there are to be worked by competent mechanics, who, on request, will exhibit their uses and management to all inquirers. In connection with the machine exhibition, there will also be established an exhibition of sample products, in process of manufacture, as well as finished. (10) In order to enable small manufacturers and tradesmen to purchase their raw materials at wholesale prices, and to facilitate the sale of their products, the formation of co-operative stores is to be encouraged. Consul Anderson has been informed that the establishment of these courses of lectures to mechanics is the initial move in a general plan to be in all the main labour centres of Germany, dependent upon the success of this experiment.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following are the chief lectures advertised for the ensuing term in the Faculty of Natural Science, in addition to the elementary courses:—Prof. Gotch, on the nervous system; Dr. Mann, on histology of sense organs; Mr. Burch,

[1] Reprinted from the *Journal* of the Society of Arts (April 14).

on dioptrics of the eye; Prof. Weldon, on Tunicata; Mr. Bourne, on the history of zoology; Mr. Thompson, on mammalian morphology; Prof. Sollas, on evolution of the earth and on palæontology; Mr. Walden, on allotropy; Prof. Miers, on isomorphism; Mr. Bowman, on rock-forming minerals; Prof. Tylor, on anthropology in classical literature. Among the mathematical lectures are:—Prof. Love, on gravitational attraction and theory of potential; Prof. Elliott, on theory of functions; Prof. Esson, on synthetic geometry of conics Among the lectures in medicine are announced:—Prof. Thomson, on the urogenital system and anatomy of the placenta and embryonic membranes; Dr. Ritchie, on pathological bacteriology; Mr. Jerome, on medical pharmacology. The new Sedleian Professor of Natural Philosophy will also give an inaugural lecture on Thursday, April 27, on "The aims and methods of natural philosophy."

The recently appointed Wilde Reader in Mental Philosophy (Mr. G. F. Stout) will also deliver an inaugural lecture on Wednesday, April 26, on "Psychology as philosophy and as science."

An examination will be held on May 16 for the Abbott Scholarship, in the subjects of mechanics and physics, and chemistry. Candidates must be sons of clergymen of the Church of England, who stand in need of assistance.

Cambridge.—The honorary degree of Doctor of Science is to be conferred on Sir William Turner, Professor of Anatomy in the University of Edinburgh, and President of the General Medical Council; and on the Rev. Thomas Wiltshire, Emeritus Professor of Geology in King's College, London. The ceremony will take place to-day (April 27). Mr. H. Jackson, First-class Natural Sciences Tripos 1896–98, has been elected a Fellow of Downing College.

The appointments of the Earl of Kimberley to be Chancellor of the University of London, in the room of Lord Herschell, deceased; and of Mr. John Arthur Thomson to the chair of Natural History in the University of Aberdeen, in succession to the late Prof. Henry Alleyne Nicholson, are formally announced in the *Gazette*.

The Board of Education Bill was read a second time in the House of Lords on Monday. Referring to the Bill, and in reply to criticisms, the Duke of Devonshire explained that the Government considered it desirable to reorganise the Education Department completely before the new local authorities for secondary education were called into existence. He knew of no insurmountable reason why a measure dealing with those local authorities should not be introduced and passed next Session. As regards the consultative committee, he remarked that the Government does not propose that it shall have any statutory character. The committee is to be the creation of the Minister, who is to be responsible for its action; and its duties are to be such as the Minister, on his responsibility, entrust to it.

The following gifts to educational institutions in the United States are announced in *Science*: Mr. William K. Vanderbilt has given 100,000 dollars to Vanderbilt University for the erection of a new dormitory on the campus.—It is reported that the sum of over 250,000 dollars has been subscribed towards an endowment for Brown University. A committee is endeavouring to collect 2,000,000 dollars, which it is intended to devote to strengthening the departments already existing in the University.—A Bill has passed the Kansas Legislature granting 55,000 dollars for the erection of a new chemistry building at the State University.—Miss Catherine Wolfe Bruce has, through Prof. J. K. Rees, given 10,000 dollars to Columbia University, to be used for the measurement and discussion of astronomical photographs. Miss Bruce's gifts to the department of astronomy amount to 22,100 dollars.

The Technical Education Board of the London County Council will proceed shortly to award not fewer than five senior county scholarships which are of the value of 60*l*. a year, together with payment of tuition fees up to 30*l*. a year, and are tenable for three years at University colleges and advanced technical institutions. These scholarships are confined to residents within the Administrative County of London, and are open only to those whose parents are in receipt of not more than 400*l*. a year. Candidates should, as a rule, be under twenty-two years of age, though the Board reserves the right to give preference to candidates who are under nineteen years of age. The scholarships are intended to enable those students who cannot afford a University training to pursue advanced studies for a period of three years in the highest University institutions in the country. Senior scholars appointed by the Board are studying at Cambridge, at colleges of University rank in London and elsewhere, and in University institutions on the continent. The Board usually makes a certain number of grants of lesser value in addition to awarding scholarships. Candidates must apply before Monday, May 15, to the Secretary of the Technical Education Board, 116 St. Martin's Lane, W.C.

With reference to the paragraph which appeared in our last issue, in regard to the proposed foundation of a University for the West of England, we find that the suggestions of the Bishop of Hereford, the President of Bristol University College, appear to be receiving serious attention. The Bishop referred to the steps being taken in Birmingham so that Mason College may be incorporated as the University of Birmingham, and thus Birmingham become the home of a Midland University. He had come to the conclusion that within reasonable limits the multiplication of such University centres was a very real stimulus to the higher life of the community: and sometimes in his day-dreams he saw the time when they would have a University of Bristol, with the sister colleges, the University College and the Merchant Venturers' Technical College, spreading new life and intelligence not only throughout the vast community of the city, but to the West of England. In regard to this, Mr. G. H. Pope, Secretary to the Merchant Venturers, writes to the local papers, and after hoping that the Bishop's dream may come true, adds that it is one "towards the ultimate fulfilment of which everything that the Merchant Venturers do for securing the completeness and perfection of their College is, not quite unconsciously, tending."

A copy of the Calendar of the School of Practical Science of the Province of Ontario, affiliated to the University of Toronto, has been received. There are five regular departments of instruction in the school, in each of which diplomas are granted, viz.:—Civil engineering (including sanitary engineering); mining engineering; mechanical and electrical engineering; architecture; analytical and applied chemistry. The regular course in each department is of three years' duration, and leads to the diploma of the school. Graduates electing to continue their studies for a fourth year are allowed to select two subjects from an approved list, and are required to confine their whole attention to these subjects during the fourth year. The subjects on this list are such as require a large amount of time to be devoted to laboratory and other practical work. During this year the student is required to prepare a thesis on some subject connected with his work. After complying with all requirements, the candidate receives from the University the degree of Bachelor of Applied Science (B.A.Sc.). Bachelors of Applied Science may, after three years spent in professional work, present themselves for the degrees of Civil Engineer (C.E.), Mining Engineer (M.E.), Mechanical Engineer (M.E.), or Electrical Engineer (E.E.), as the case may be, subject to the rules and regulations established by the University. Toronto thus gives the encouragement to engineering which Mr. Stuart recently urged (see p. 524) should be more liberally given in our own Universities.

The nineteenth annual report of the Council of the City and Guilds of London Institute, referring to the work of the Institute during the year 1898, has just been issued. A letter sent to the London University Commission by the Institute, and published in the report, is of interest as it states the conditions under which the Institute is willing to accept the position of a School of the University for its Central Technical College. The conditions include the following:—"That, in addition to the Faculty of Science in the reconstituted University, a special separate Faculty of Engineering ought to be created to meet the needs of Schools of the University which are preparing students for a professional career. This Engineering Faculty should have direct representation on the Senate, and should include the subjects of civil engineering, mechanical engineering, electrical engineering, marine engineering, mining engineering, and might possibly also include chemical engineering, metallurgy, architectural construction, and sanitary engineering. The Institute is of opinion that as it appears undesirable, at all events in the first instance, to constitute unduly large faculties, each faculty should consist of the professors alone of the several schools included in the faculty." The Institute has been in-

vited by the Education Sub-Committee of the Royal Commission for the Paris Exhibition of 1900 to co-operate in the work of securing for the exhibition an adequate and comprehensive representation of all grades of educational effort, public and private, in the United Kingdom, and Sir Owen Roberts has been appointed by the Executive Committee to attend the conferences convened by the Chairman, Sir George Kekewich, K.C.B., to consider the arrangements for the educational section.

SCIENTIFIC SERIALS.

American Journal of Science, April.—Glacial Lakes Newberry, Warren, and Dana in Central New York, by H. L. Fairchild. The ice sheet of the last glacial epoch covered all the area of the Great Lakes. When the receding front of the glacier had passed to northward of the southern boundary of the Laurentian basin, the glacial and meteoric waters were impounded between the ice front and the north-sloping land surface. These glacial lakes had their outlets southward across the divide, and they expanded northward as the barrier of ice receded. The author describes the succession of events in the life and extinction of the later and broader glacial waters in the critical district of the Finger Lakes.—Rapid method for the determination of the amount of soluble mineral matter in a soil, by T. H. Means. This method is an electrical one. The sample is treated with distilled water and the specific resistance of the solution is determined. Two men can thus examine from sixty to one hundred samples of soil in a day, and salt maps of irrigated and other districts may be rapidly constructed.—New type of telescope objective specially adapted for spectroscopic use, by C. S. Hastings. The author has constructed an objective consisting of a quadruple combination of silicate flint, borosilicate flint, silicate crown, and barium crown which is absolutely colour-free, and equally adapted to photographic and to eye observations. From the lines A to K, the focal plane for all rays is rigidly the same. There are only two free surfaces, the four lenses being cemented together.—On the phenocrysts of intrusive igneous rocks, by L. V. Pirsson. Not all phenocrysts are intratelluric in the sense that they have been formed at much greater depths than they now occur in. On the contrary, in many cases they have been formed in place, and are of contemporaneous origin with the other constituents of the rocks.—The occurrence, origin, and chemical composition of chromite, by J. H. Pratt. The author has been led to adopt the theory that the chromite occurring in the peridotite rocks of North Carolina was formed at the same time as the peridotite, *i.e.* was held in solution by the molten mass of the peridotite and crystallised out among the first minerals as the mass began to cool.—Two species of Saurocephalus, by O. P. Hay. One of the species described, *S. lanciformis*, is little known. The other species is new. It has a slenderer head and a larger mouth than *S. dentatus*. The author names it *S. pamphagus*.

Correction.—The abstract of G. P. Starkweather's paper, *Am. J. Sc.* for February, should read: The writer adduces evidence from Regnault's own experiments to show that his calorimeter temperatures were reduced to the air thermometer, a fact questioned by Bosscha and others.

Symons's Monthly Meteorological Magazine, April.—Winter minima on British mountain tops. In 1867, the late Mr. H. B. Biden placed a minimum thermometer on the Glyder fach, about four miles E.N.E. of Snowdon, at an altitude of 3262 feet. The thermometer was placed beneath a protecting slab of feldspar porphyry, and left to its fate, being read each spring, and then reset. Mr. W. Piffe Brown has discussed the temperatutes in the *Climbers' Club Journal* for February last. The average for the years 1884–96 except 1894–95, when the record was lost) was 14°·7, the absolute minimum being 8°, in the winter of 1893–94. The accumulation of snow may account for the readings not being lower, but it is improbable that there was always snow there at times of severe cold. At Ben Nevis, the average of the minima for the same period is 7°·5, the absolute minimum being 0°·7 in January 1894. A very contradictory record was obtained by the late Dr. J. F. Miller at Scaw Fell, where the wonderful temperature of −31° was recorded for January and February 1850.—Negretti and Zambra's self-recording rain gauge. Mr. Symons states that this is a very simple and efficient instrument; the rain collected by the receiver falls into the upper half of the vibrating bucket (designed by Sir Christopher Wren). When 0·1 inch of rain has fallen, the bucket tips over and causes a wheel to advance one tooth. Attached to the wheel is a helix on which rests the lever carrying the pen which registers each turnover of the bucket. As the clock (the useful invention of MM. Richard frères) turns the paper about ·001 inch per minute, a very clear curve is produced. The approval of the instrument by Mr. Symons is a guarantee of its usefulness, and the cost is much below some other recording gauges.

THE *Journal of the Royal Microscopical Society* for April contains the President's annual address, which is chiefly devoted to the subject of dispersion; the description of a microscope with new focussing mechanism, by Mr. Keith Lucas; and notes on colour-illumination, with special reference to the choice of suitable colours, by Mr. Julius Rheinberg. Among the notes on microscopy is a contribution to the President's interesting article on the evolution of the microscope, and a description of Powell's iron microscope made in 1838–40. In the same number is a table of the conversion of British and metric measures, computed by Mr. E. M. Nelson from the new coefficient obtained by order of the Board of Trade in 1896.

Wiedemann's Annalen der Physik und Chemie, No. 3.—Behaviour of unpolarisable electrodes towards alternate currents, by E. Warburg. If polarisation is altogether due to the solution of the electrode metal in the liquid and its attendant changes of concentration, the "capacity of polarisation" must be inversely proportional to the square root of the frequency. This applies to the case of silver electrodes in silver nitrate solution, and, to a certain extent, to platinised platinum electrodes in saturated NaCl solution.—Methods of studying slow electric oscillations, by W. König. The author describes several new methods of recording and studying electric oscillations of a frequency comparable with that of ordinary sound-waves. One of these consists in discharging them through a rod provided with a short piece of straw at the end on to a metallic plate covered with asphalt varnish. The sparks produce on the plate something resembling Lichtenberg's figures. The plate is attached to a pendulum, and is drawn across the point. On sprinkling the plate with a mixture of sulphur and red lead a series of red and yellow patches appears, which in connection with the known speed of the pendulum gives the frequency of the sparks. The straw may also be attached to the vibrating prong of a tuning-fork, and so a more direct measurement obtained. The straw is necessary to reduce the intensity of the spark, so as to obtain a sharp line.—A new method of exhibiting electric wire waves, by W. D. Coolidge. The author obtains a glow of the wires of a Lecher wire system at the ventral segments of the stationary waves in the open air by using a Blondlot exciter worked with an induction coil and Tesla transformer, and reducing the thickness of the wire to 0·1 mm.—Alternate-current energy consumed in vacuum tubes, by H. Ebert. Very high frequencies were employed, such as 22,000 oscillations per minute. It was found that at a certain high exhaustion the consumption of energy for a given luminous effect attained a minimum. The pressure at which this takes place is inversely proportional to the mean free path of the gaseous molecules.—Absolute determination of thermal radiation by means of the electric compensating pyrheliometer, by K. Ångström. Of two equal blackened strips of metal, one is exposed to the radiation while the other is brought to the same temperature by means of an electric current. The latter furnishes a measure of the radiation.—Measurement of flame temperatures by means of thermo-couples, by F. Berkenbusch. Two new methods devised by Nernst are tested.—Pressure of saturated water vapour below 0°, by M. Thiesen. The author calculates the vapour pressures over ice and over water respectively down to −80°.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, April 21.—Mr. T. H. Blakesley, Vice-President, in the chair.—A mathematical paper on the effect of a solid conducting sphere in a variable magnetic field on the magnetic induction at a point outside, was read by Mr. C. S. Whitehead. It is an investigation of the magnetic induction at a point outside a solid conducting sphere when magnetic dis-

turbances are taking place in the dielectric envelope. An expression is given for the maximum value of the magnetic induction when the sphere becomes an infinite plate and the inducing system consists of an alternating current in a circular circuit whose plane is parallel to the plate, *i.e.* when the maximum value of the induction tangential to the surface is zero. A second expression gives the maximum value of the magnetic induction normal to the surface for a point at considerable distance from the axis, and just outside the plate. In this latter case, the maximum value of the induction tangential to the surface appears as a function of the maximum current of known frequency in the inducing circuit, the various dimensions in space of the system, and the permeability and specific resistance of the plate. From these equations, taking the most authentic values of the involved constants, the maximum magnetic induction normal to the surface for a sea-water plate is forty-four times as great as it would be for an iron plate, and more than three thousand times as great as it would be for a copper plate. The paper also shows that, for the purpose of induction telegraphy, to get the best effect the receiving coil should have its plane vertical, not horizontal, firstly because the distance of the inducing circuit from the surface of the plate must in practice be small compared with the distance of the point from the axis, so that the maximum normal induction is small compared with the maximum tangential induction; and secondly because the maximum *normal* induction varies inversely as the *fifth* power of the distance of the point from the axis, whereas the maximum tangential induction varies inversely as the fourth power of that distance. In conclusion, Mr. Whitehead applies his formulæ to the practical case mentioned by Prof. Lodge in the *Journal* of the Institute of Electrical Engineers, February 1899, p. 805. Prof. Lodge there describes a horizontal receiving circuit, and states that, with no condensers in the circuit he "was not usually able to hear anything" in the telephone. Mr. Whitehead calculates that under such conditions the theoretical value of the current in Prof. Lodge's horizontal secondary is 0·066 *micro*-amperes, but that with a vertical circuit the received current would have been 33 *milli*-amperes. Mr. Blakesley observed that as a rule experiment preceded theory. He congratulated Mr. Whitehead upon having settled from theoretical considerations that the vertical position of the receiving coil is best. Prof. Everett said that the very elaborate method of analysis adopted in the paper appeared to be very clearly stated. He would like to know whether the inducing coil ought to be vertical as well as the receiving coil. Mr. Appleyard thought that experiment had left no doubt as to the best position of both coils. The early investigations of Mr. Willoughby Smith and the later work of Mr. H. R. Kempe and Mr. Preece had proved that for the best effect both coils should be vertical. But large vertical coils were difficult to fix and expensive to maintain. It was this reason probably that led Prof. Lodge to try what could be done with coils placed horizontally Mr. Whitehead, in reply, said that his formulæ only applied to a horizontal inducing coil. He had not worked out the case of what would happen if the inducing coil itself was vertical. In the experiments on the Flat Holm both circuits were straight wires with their ends to earth, so that they really amounted to vertical coils.—Mr. R. A. Lehfeldt then gave a demonstration of a method due to Prof. T. W. Richards for standardising thermometers. This depends upon the ordinary latent-heat principle for maintaining constant temperature, but it includes the consideration of generally more than two states or phases of the melting substance. If there are c components and p phases, then the number of degrees of freedom of the system is $[c + 2 - p]$. When this is zero, the temperature and the pressure of the system are perfectly definite. Thus the following chemical formula represents the four phases to be equilibrated in the case of Glauber's salt:

$$\begin{cases} Na_2SO_4 10H_2O \\ Na_2SO_4 \\ \text{Solution} \\ \text{Vapour.} \end{cases}$$

Prof. Richards has determined the temperature of equilibrium in several useful cases. The salts are put into a test-tube in an air-bath formed between it and a second test-tube; the whole is then heated in a beaker of water over a small flame. If the salt is pure, and care is taken to avoid the effect of supersaturation, this method is highly satisfactory. It gives an extensive range of fixed-points, and is especially useful in thermometry for fixed-points between 0° and 100°. A few of these temperatures may be noted:

	°C
Sodium chromate	19·71
Sodium carbonate	53·3
Sodium thiosulphate	48·0
Sodium bromide	50·8
Manganese chloride	57·8
Trisodium phosphate	73·4
Barium hydroxide	78·0

Mr. J. A. Harker asked how long the temperature remained constant. The special value of Richards' method for standardising thermometers of short range had been pointed out by Dr. Chree. It obviated the necessity for auxiliary bulbs, and it would be extremely useful in graduating meteorological thermometers. Mr. Blakesley said that sodium chromate was represented by a very useful temperature. Could this substance be regarded as sufficiently stable to give a satisfactory fixed-point. Mr. Lehfeldt, in reply, said that all the fixed-points mentioned were theoretically as definite as that corresponding to sodium sulphate, but they had not been so accurately determined.

Geological Society, April 12.—W. Whitaker, F.R.S. President, in the chair.—Mr. A. M. Davies, in exhibiting a specimen of glauconitic limestone from the Kimeridge clay, said that it might easily be taken for upper greensand. There are traces of fossils in the stone, but an impression of a *biplex* ammonite was alone recognisable. No similar bed had been previously recorded from the English Kimeridgian.—Fossils in the University Museum, Oxford: (1) Silurian echinoidea and ophiuroidea, by Prof. W. J. Sollas, F.R.S. Attention is called to the correlation of structure and function in the locomotive organs of asterids, ophiurids, and echinids.—Note on the occurrence of sponge-spicules in the carboniferous limestone of Derbyshire, by Prof. W. J. Sollas, F.R.S. Remains of sponge-spicules are fairly abundant in a rock-slice taken from a specimen obtained by Mr. H. H. Arnold-Bemrose from Tissington cutting. They present themselves as sections through long cylindrical rods, but the terminations are obscure and indefinite, and the form cannot be referred with certainty to any recognised order of sponges. The spicules were doubtless originally siliceous, but they are now completely transformed into carbonate of lime.—On spinel and forsterite from the Glenelg limestone, by C. T. Clough and Dr. W. Pollard; communicated by permission of the Director-General of H.M. Geological Survey. The paper opens with an account of previous literature on the subject of minerals in the Glenelg limestone. Neither forsterite nor true spinel has been previously recorded from the limestone or from Scotland at all. The forsterite and spinel are in part associated together in lumps, from which they were separated by means of heavy solutions for analysis. The spinel in hand-specimens is of an almost opaque blue colour, and some examples show small crystal-faces. That seen in microscopic slides is shapeless and colourless, except that the blue portions appear brown by transmitted light. Analyses of the two minerals are given at the close of the paper; and it is pointed out that the spinel is like that of Aker in colour and mode of occurrence.

Mineralogical Society, April 11.—Mr. R. H. Scott, Past-President, in the chair.—Mr. F. R. Mallet gave the results of the examination of a mineral obtained many years ago from the Mayo salt mines, Punjab: he proves it to be Langbeinite, sulphate of potassium and magnesium ($K_2SO_4.2MgSO_4$), a species first established in 1891 from material found in the Prussian salt deposits.—Mr. L. Fletcher gave an account of a mass of meteoric iron from Patagonia, a fragment of which had been brought to this country by Dr. F. P. Moreno of La Plata; the material contains nearly 10 per cent. of nickel and cobalt, and belongs to the class of octahedral meteoric irons, like that of Toluca.—Mr. G. F. H. Smith read a paper on the use and advantages of a three-circle goniometer. The older form of goniometer with one circle has the grave disadvantage that the crystal must be re-adjusted for different zones. In the case of the theodolite goniometer with two circles, the crystal is adjusted once for all, and measurements are made of the polar distance and azimuthal angle of each face; but by this method no use can be made of the law known as the anharmonic ratio of four poles in a zone, and in fact the indices of faces are not readily determin-

able. By adding a third circle, the advantages of both methods may be combined. The crystal is adjusted once for all, and measurements may be made in any zone at will. One circle gives the angle in this zone, the second the angle this zone makes with a fixed zone, and the third the pole in which this zone intersects the fixed zone. A short description was given of the apparatus necessary to convert an ordinary goniometer into the three-circle form, which is now under construction by Messrs. Troughton and Simms.

Royal Meteorological Society, April 19.—Mr. F. C. Bayard, President, in the chair.—Mr. H. Mellish read a paper on soil temperature, in which he discussed the observations from the thermometers at various depths in the soil which have been made at the stations of the Royal Meteorological Society. These records have been carried on at many of the stations since 1881, and observations have been made at the following depths in the soil: 3 inches, 6 inches, 1 foot, 2 feet, and 4 feet. It appears that in nearly all cases the annual temperature of the soil at the depth of 1 foot is slightly higher than that of the air. In winter time the air and the soil at 1 foot have about the same temperature, the soil being often a little warmer till about the end of January, after which, for the next two months, the air has a small advantage; but in the summer months the soil at 1 foot is generally warmer than the air, the difference exceeding 3° at several stations. Mr. Mellish shows that on the mean for the year the light soils are 1°·0 warmer than the air, while the strong ones are only 0°·2 warmer; and he is of opinion that near the surface we may expect to find wider extremes of temperature in light soils than in strong ones; but that the heavier soils are better conductors of heat, and that consequently the extremes are propagated to greater depths in heavy soils than in light ones.—A paper on some phenomena connected with the vertical circulation of our atmosphere, by Major-General H. Schaw, C.B., R.E., was read by the Secretary. The author has for some time past been studying the circulation of the atmosphere over Australasia, and in this paper gives the results of his examination of the weather charts, chiefly in regard to the interaction of cyclones and anticyclones upon each other.

PARIS.

Academy of Sciences, April 17.—M. van Tieghem in the chair.—On the transformation of surfaces of total constant curvature, by M. Gaston Darboux.—New researches on the heats of formation and combustion of several nitrogen compounds, by MM. Berthelot and G. André. Determinations are given for cholesterine, glycollic and lactic nitriles, xanthine, paraphenylene-diamine, nicotine, pyrrol, carbazol, indol, scatol, oxindol, and α-methylindole.—On the applications of aluminium, by M. A. Ditte. A reply to some observations of M. Moissan on the same subject.—Remarks by M. Berthelot on his work "Animal Heat."—Observations on the planet E L Coggia made at the Observatory of Toulouse with the Brunner equatorial of 23 cm. aperture, by M. F. Rossard.—On some ancient showers of shooting-stars, by M. D. Eginitis.—On the periodic integrals of linear partial differential equations of the first order, by M. Levi-Civita.—Extension of the theorem of the mean to differential equations of the first order, by M. Michel Petrovitch.—On the theory of fundamental functions, by M. W. Stekloff.—Improvements in the electrolytic interrupter of Wehnelt, by M. J. Carpentier. By carefully insulating thermally the electrolytic cell, the temperature is allowed to rise from 80° to 100° C.; as the temperature rises, a smaller voltage is required in the primary circuit. If the length of platinum wire exposed is capable of adjustment, more control is obtained over the working of the coil.—Contribution to the study of the Wehnelt interrupter, by M. H. Armagnat.—On the decomposition of a high potential current into a series of disruptive discharges, by M. H. Abraham.—A cathodic rectifier for induced currents, by M. P. Villard. A Crookes' tube has one bulb of 400 cc. capacity, carrying a large wire spiral as electrode, the other electrode being very small, a few millimetres only in diameter, placed in a narrow tube which is slightly contracted just in front of the disc. This tube, when connected to an induction coil round the primary of which an alternating current is passing, allows only one alternation of the two induced currents to pass, thus acting as a rectifier.—On silver suboxide, by M. Guntz. When Ag_2O is heated in a strong sealed tube at 358°, there is a certain equilibrium (about 49 atmospheres) corresponding to the dissociation tension of Ag_4O. That this pressure corresponds to the suboxide was shown by the following experiment. Into a glass tube of known volume is placed sufficient $KMnO_4$ to give off at 358° oxygen at a pressure just above 50 atmospheres, and two glass tubes containing known weights of silver and silver oxide respectively; and the whole is heated for three days to 358° C. Analysis of the products showed that the Ag_2O had lost weight and the silver had gained weight, and that the gain and loss corresponded exactly in both cases to the formation of Ag_4O.—On the solubility of the normal acids of the oxalic series in water, by M. F. Lamouroux. The acids of the oxalic series, both of odd and even numbers of carbon atoms, are in general slightly soluble in water, the only exceptions being malonic and glutaric acids, which are very soluble.—On the solubility in water of the substituted malonic acids, by MM. G. Massol and F. Lamouroux. Various mono- and di- substituted malonic acids were examined up to acids containing eight atoms of carbon, but no regularities could be deduced.—Action of ethyl, isobutyl, and isoamyl alcohols upon their sodium derivatives, by M. Guerbet. By heating pure inactive amyl alcohol at 150°–160° with its sodium derivative, a new alcohol, diamyl alcohol, $C_{10}H_{22}O$ was obtained, from which various derivatives were obtained, including the chloride, acetate, isovalerate, and benzoate. Bisulphate of potassium gave a hydrocarbon $C_{10}H_{20}$, and oxidation with chromic acid a new acid $C_{10}H_{20}O_2$. Ethyl alcohol studied in a similar fashion, gave at 210° hydrogen and ethylene, but no product corresponding to the diamyl alcohol.—Action of very dilute acids upon the phosphates of the soil, by M. Th. Schlœsing, jun.—On a simple measuring apparatus for use in stereoscopy, the stereometer, by MM. T. Marie and H. Ribaut.—General considerations on the defensive glands in the Coleoptera, by M. L. Bordas.—On the Trias of the neighbourhood of Rougiers (Var), and on the existence in this region of phenomena analogous to the peperites of Auvergne, by M. J. Repelin.—On the origin of the siliceous and quartose grains found in chalk, by M. Stanislas Meunier.

AMSTERDAM.

Royal Academy of Sciences, February 24.—Prof. Van de Sande Bakhuyzen in the chair.—Prof. Schoute reported, in the name of Prof. Korteweg and himself, upon a paper of Mr. S. L. van Oss, entitled "Das regelmässige Sechshundertzell und seine sellstdeckenden Bewegungen." The paper will be published in the Academy's *Transactions*.—Prof. Jan de Vries, on orthoptic circles belonging to linear systems of conic sections.—Prof. Bakhuis Roozeboom, on solubility and melting point as criteria for the distinction of racemic compounds, partially racemic compounds, pseudoracemic mixture crystals and inactive conglomerates.—Prof. Schoute, on a geometric interpretation of the generalisation of Sylvester's catalecticant.—The above three communications will be inserted in the report of the meeting.—Prof. Haga made, both on behalf of himself and Dr. C. H. Wind, a communication on the diffraction of Röntgen rays. Diffraction of X-rays was proved by an experiment arranged as follows: The Röntgen-tube was placed behind a slit 1 c.m. high and 14 microns wide, at 75 c.m. from the latter was the diffraction slit, which gradually diminished in width from 17 to about 2 microns. The photographic plate was placed at 75 c.m. from the diffraction slit. Time of exposure from 100 to 200 hours. The image of the slit first became narrower, and then showed an unmistakable broadening. From the width of the part of the diffraction slit, corresponding to this broadening and the character of the broadening, an estimation can be made of the wave-length. It appeared that X-rays exist of about 0·1 to 2½ Ångström-units, comprising four octaves.—A detailed paper will appear in the report of the next meeting.—Prof. Stokvis presented for publication in the *Proceedings* a short account of experiments, made by Dr. G. Bellaar Spruyt in his laboratory, on the physiological action of methylnitramine. From these experiments it appears that the nitramines show no nitrite actions whatever in the animal organism, and that, consequently, as homologous chemical structure necessarily brings with it homologous physiological action, in accordance with Franchimont's view, they must be considered substances in which nitrogen is most probably cyclically combined.—The following papers were presented for publication in the *Proceedings*:—Two communications by Prof. Lorentz (*a*) on a simplified theory of the electrical and optical phenomena in moving bodies (*b*) Stokes's aberration theory presupposing an ether of unequal density. Two communications by Dr. J. Verschaffelt, presented by Prof. Kamerlingh Onnes, and entitled (*a*) measurements on

the course of the isotherms in the proximity of the plait point, and specially on the course of the retrograde condensation in the case of a mixture of carbonic acid and hydrogen (continuation); and (*b*) measurements on the variations of pressure on one component, being substituted for another in mixtures of carbonic acid and hydrogen. A paper by Dr. Ernst Cohen, presented by Prof. Bakhuis Roozeboom, and entitled, "On electrical reaction velocity." A communication by Prof. Franchimont, concerning the dissertation of Mr. L. T. C. Schey, presented to the library of the Academy, and entitled "On neutral glycerine esters (triacylines) from saturated monobasic acids with an even number of C-atoms." The dissertation gives an account of the preparation of the following substances, all of which were obtained by heating the acid with glycerine in a space filled with rarified air, and with a slight current of air:—Tributyrine, tricaproine, tricapryline, tricaprine, trilaurine, trimyristine, tripalmitine, and tristearine. The first three are liquids, the others solids. The density, the index of refraction, and the melting-point of each of them, were determined. The melting-point of tricaprine is the same as that of caprine acid; the melting-points of the lower terms of the acylines are below those of the corresponding acids, those of the higher terms are higher.—This work will be published in the "Recueil des Travaux chimiques des Pays-Bas et de la Belgique."

DIARY OF SOCIETIES.

THURSDAY, April 27.

Royal Society, at 4.30.—Data for the Problem of Evolution in Man. I. A First Study of the Variability and Correlation of the Hand: Miss Whiteley and Prof. Karl Pearson, F.R.S.—The Luminosity of the Rare Earths when Heated *in vacuo* by means of Cathode Rays: A. A. C. Swinton.—On a Quartz Thread Gravity Balance: R. Threlfall and J. A. Pollock.—On the Electrical Conductivity of Flames containing Salt Vapours: H. A. Wilson.—On a Self-recovering Coherer and the Study of the Cohering Action of Different Metals: Prof. J. C. Bose.—On the Presence of Oxygen in the Atmospheres of certain Fixed Stars: Dr. Gill, F.R.S.

Royal Institution, at 3.—The Atmosphere: Prof. J. Dewar, F.R.S.

Institution of Electrical Engineers, at 8.—Experiments on Alternate Current Arcs by Aid of Oscillographs: W. Duddell and E. W. Marchant. (Conclusion of Discussion.)—Capacity Measurements of Long Submarine Cables: J. Elton Young.

Institution of Mechanical Engineers, at 7.30.—Address by the President, Sir William H. White, K.C.B., F.R.S.

FRIDAY, April 28.

Royal Institution, at 9.—Some Features of the Electric Induction Motor: Prof. C. A. Carus Wilson.

Institution of Mechanical Engineers, at 7.30.—Evaporative Condensers: Harry G. V. Oldham.

MONDAY, May 1.

Society of Arts, at 8.—Leather Manufacture: Prof. H. R. Proctor.

Victoria Institute, at 4.30.—Nationality: Prof. T. McK. Hughes, F.R.S.

TUESDAY, May 2.

Royal Institution, at 3.—Electric Eddy Currents: Prof. S. P. Thompson, F.R.S.

Zoological Society, at 8.30.—Sur le Type Primitif des Molaires Plexodontes des Mammifères: Dr. F. Ameghino.—Notes on Chinese Mammals, principally from the Western Province of Sechuen: W. E. de Winton.—On a Collection of Land-Shells from British Central Africa: Edgar A. Smith.

WEDNESDAY, May 3.

Society of Arts, at 8.—Ætheric Telegraphy: W. H. Preece, C.B., F.R.S.

Society of Public Analysts, at 8.—On some Comparative Analyses of, and Digestive Experiments with White and Whole Meal Breads: Dr. Otto Rosenheim and Dr. Phillip Schidrowitz.—The Assay of Belladonna, B.P.: F. C. J. Bird.—On the Use of Boric Acid and Formaldehyde as Milk Preservatives: Dr. S. Rideal and G. R. Foulerton.—The Value of the Estimation of Pentosans in Food Materials: Otto Hehner and W. P. Skertchly.

Entomological Society, at 8.

THURSDAY, May 4.

Royal Society, at 4.30.—*Onygena equina* (Willd.): a Horn-destroying Fungus: Prof. Marshall Ward, F.R.S.—Impact with a Liquid Surface studied by the Aid of Instantaneous Photography. Paper II.: Prof. Worthington, F.R.S., and R. C. Cole.—The External Features in the Development of *Lepidosiren paradoxa* (Fitz.): J. G. Kerr.—An Observation on Inheritance in Parthenogenesis: Dr. E. Warren.—The Thermal Expansion of Pure Nickel and Cobalt: A. E. Tutton.

Linnean Society, at 8.—The Position of Anomalurus as indicated by its Myology: F. G. Parsons.—On *Notheia anomala*, Harv. et Bail.: Miss Ethel S. Barton.—On Variation in the Desmidiæ: G. S. West.

Chemical Society, at [illegible].—On the Combustion of Carbon Disulphide: H. B. Dixon and E. J. Russell.—The Action of Nitric Oxide on Nitrogen Peroxide: H. B. Dixon and J. D. Peterkin.—On the Mode of Burning of Carbon: H. B. Dixon.—Crystalline Glycollic Aldehyde: Henry J. Horstman Fenton and Henry Jackson.—On the Blue Salt of Fehling's Solution and other Cupro-tartrates: Orme Masson and B. D. Steele.—The Preparation of Acid Phenolic Salts of Dibasic Acids: Dr. S. B. Schryver.—The Maximum Pressure of Napthalene Vapour: R. W. Allen.

Institution of Electrical Engineers, at 8.—Electric Locomotives in Practice and Tractive Resistance in Tunnels, with Notes on Electric Locomotive Design: G. V. McMahon.

FRIDAY, May 5.

Royal Institution, at 9.—Pictures produced on Photographic Plates in the Dark: Dr. W. J. Russell, F.R.S.

Geologists' Association, at 8.—The Drainage of Cuestas: Prof. W. M. Davis.

SATURDAY, May 6.

Geologists' Association.—Excursion to the Thame District. Director: A. M. Davies. Leave Paddington at 9.50.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Statesman's Year-Book, 1899 (Macmillan).—The Arithmetic of Chemistry: Dr J. Waddell (Macmillan).—How to Know the Ferns: F. T. Parsons (New York, Scribner).—Premiers Principes d'Electricité Industrielle: P. Janet, trois édition (Paris, Gauthier-Villars).—Royal University of Ireland, Calendar, 1899 (Dublin, Thom).—The Spirit of Organic Chemistry: Prof. A. Lachman (Macmillan).—A Course of Practical Chemistry: M. M. P. Muir, Part 2 (Longmans).—Plato and Darwin: The Abbé M. Hébert, translated by Hon. W. Gibson (Longmans).—Cape of Good Hope, Department of Agriculture, Annual Report of the Geological Commission, 1897 (Cape Town).

Pamphlets.—Field Columbian Museum, Annual Report, 1897–98 (Chicago).—Tre Nebulose fotografate recentemente alla Specola Vaticana: P. G. Lais (Roma).

Serials.—Scientia, Nos. 1 to 3 (Paris, Carré).—Journal of the Franklin Institute, April (Philadelphia)—Zoologist, April (West).—Journal of Anatomy and Physiology, April (Griffin).—Bulletin de la Classe des Sciences, 1899, Nos. 1 and 2 (Bruxelles).—Journal of the Institution of Electrical Engineers, April (Spon).—Among British Birds in their Nesting Haunts: O. A. J. Lee, Part xiv. (Edinburgh, Douglas).—Journal of the Sanitary Institute, April (London).—Jahrbuch der K. K. Geologischen Reichsanstalt, xlviii. Band, 2 Heft (Wien).—Quarterly Review, April (Murray).—Journal of the Chemical Society, April (Gurney).

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No. 1518, VOL. 59] THURSDAY, DECEMBER 1, 1898. [PRICE SIXPENCE.

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No. 1519, VOL. 59] THURSDAY, DECEMBER 8, 1898. [PRICE ONE SHILLING.

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CHARITY COMMISSION.

In the Matter of the Charity consisting of the Chelsea Physic Garden, in the Parish of Chelsea, in the County of London, and the Charities called The City Parochial Foundation, in the County of London and elsewhere; regulated by the Central Scheme made under the City of London Parochial Charities Acts, 1883, on February 23, 1891, as modified by a Scheme of the Charity Commissioners of May 28, 1897; and

In the Matter of "The Charitable Trusts Acts, 1853 to 1894."

By direction of the Board of Charity Commissioners for England and Wales, NOTICE is hereby given that an Order is proposed to be made by them after the expiration of one calendar month, to be computed from the first publication of this Notice, establishing a SCHEME for the administration of the above-mentioned Charity called the Chelsea Physic Garden, and for the further Modification of the above-mentioned Scheme regulating the above-mentioned Charities called The City Parochial Foundation.

Any objections to the proposed Order or suggestions thereon may be transmitted to the said Commissioners in writing within twenty-one days next after the first publication of this Notice addressed to "The Secretary, Charity Commission, Whitehall, S.W."

Printed Copies of the proposed Scheme may be inspected free of cost on each week-day during a period of fifteen days from the first publication of this Notice between the hours of 11 a.m. and 5 p.m. (Saturdays excepted) at the Offices of the City Parochial Foundation, No 3 Temple Gardens, and between the hours of 10 a.m and 4 p.m. at the Office of the Commissioners, where also Copies may be purchased during the same period at the price of 6*d.* each, which may be remitted by Postal Order, crossed "Bank of England," or, if the amount be less than One Shilling, in Penny postage stamps.

Dated this 23rd day of November, 1898.

D. R. FEARON, Secretary.

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M. C. TAYLOR, Secretary, University Court.

University of Edinburgh, December 5, 1898.

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No. 1521, Vol. 59] THURSDAY, DECEMBER 22, 1898. [Price Sixpence.

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No. 1522, Vol. 59] THURSDAY, DECEMBER 29, 1898. [Price Sixpence.

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QUERNMORE. LONDON BRANCH at 24 CHANCERY LANE, W.C.

Tuition by JOHN GIBSON, M.A. (First Class, Camb.), and G. LOLY, B.A. (First Class, London), for all Public Examinations. **Special Instruction in Scientific Agriculture** for successful practical Agriculture and Forestry in the British Islands or the Colonies; also in Geology, Botany, &c., Practical, Chemical, and Physical Laboratories. The "State Correspondent" and Higher Examination Journal gives up-to-date particulars of all the leading C.S. and other Examinations. Price 2½d., post free. Prize of One Guinea for competition each month; Special Prize of **Five Guineas** each June and December.

VICTORIA UNIVERSITY.

THE YORKSHIRE COLLEGE, LEEDS.
DEPARTMENT OF SCIENCE, TECHNOLOGY, AND ARTS.

The Next Term begins Tuesday, January 10.
Prospectus (post free) from the REGISTRAR.

COACHING.
CHEMISTRY, PHYSICS, BIOLOGY.

All Examinations Conjoint Board, University of London, D. P. H., &c. Theoretical and Practical. Small Classes or Private Tuition. Well-fitted Laboratories. Practical Forensic Medicine.—"R. C.," 9 Heathcote Street, Gray's Inn Road, London, W.C.

EAST LONDON TECHNICAL COLLEGE,
PEOPLE'S PALACE, MILE END ROAD.

Director of Studies—J. L. S. HATTON, M.A.

Professors:

Engineering	D. A. LOW (Wh. Sc.), M.I.M.E.
Chemistry	J. T. HEWITT, M.A., D.Sc., Ph.D.
Physics	R. A. LEHFELDT, B.A., D.Sc.
Art	R. CHRISTIE.

The new Term for the Engineering and Chemistry Courses, for Students over 15 years of age, commences on January 9. Fees for the first year, £7 7*s*.; for the second and third year, £12 12*s*. There are excellent Laboratories and Workshops. Eight Scholarships, embracing free education at these Classes and payments of £10 the first year and £15 the second year, are given annually by the Drapers' Company.

Art Course commences January 9. Fees up to £2 2*s*. a Term. Full particulars on application to the DIRECTOR OF STUDIES.

GOVERNMENT GRANT FOR SCIENTIFIC INVESTIGATIONS.
January 31 is the Last Day for receiving Applications, which must be written upon printed forms to be obtained from the undersigned, and must be forwarded to the Royal Society, Burlington House, London, W., in envelopes marked "Government Grant."

HERBERT RIX, B.A., Clerk to the Committee.

THE GRAHAM MEDAL, to be awarded
for Original Research in any branch of Chemical Science, is now open to competition.

Information regarding the conditions under which the Award will be made, can be had on application to the SECRETARY of the Philosophical Society of Glasgow, 207 Bath Street, Glasgow.

LIVERPOOL SCHOOL BOARD.

The Board requires, as soon as possible, the services of an ASSISTANT SCIENCE DEMONSTRATOR. The person appointed must be qualified to take part in the experimental science teaching (Mechanics, Chemistry, and Physics) given in the Board's Schools. Salary, £100 first year, rising in four years to £120, with an extra annual payment from £3 to £11 if the applicant holds Science and Art Certificates and University distinctions, and also a small proportion of the grant received for the classes, if any, taught under the Science and Art Department. Applications, stating age, qualifications, and experience, must be received not later than Monday the 9th January, 1899, addressed to EDWARD M. HANCE, Clerk to the Board, School Board Office, Sir Thomas Street, Liverpool.

24 December 1898.

SECRETARY WANTED for the DURHAM
COLLEGE OF SCIENCE, Newcastle-upon-Tyne, to enter on the Office immediately. The Duties, to which his whole time must be devoted, are of a very various kind, amongst them being attendance on Committees, oversight of the College Premises and Servants, responsibility for Minutes, Correspondence, Reports, Accounts, &c. Age not more than 40. Salary to begin at £250.

Applications, stating age and qualifications, and enclosing testimonials, must be sent to the PRINCIPAL on or before January 7, 1899.

UNIVERSITY COLLEGE, LONDON.

The Quain Studentship in Biology (Botany Section) is Vacant. Candidates (who must have attended for at least Three Terms one or more Classes in Botany at the College) should forward their applications to the SECRETARY by February 1.

They should give particulars of their College Course, and of any distinctions gained at the Universities or elsewhere.

The value of the Studentship is £100 per annum. The Appointment is for three years.

T. GREGORY FOSTER, Ph.D.,
Acting Secretary.

TO SCIENCE MASTERS.—Wanted, for
London Coaching Establishment, Senior Lecturer in Botany. Hons. Graduate essential. Salary £200, non-res. Also Asst. Demonstrator in Physics, and to take Elem. Mathes. Salary £100, non-res. Also Junior Science Master, able to earn Grants—Schl. North of England. Salary £100, non-res. Address, GRIFFITHS, SMITH, POWELL & SMITH, Tutorial Agents, 34 Bedford Street, Strand.

RESEARCH.
CHEMISTRY AND PHYSICS.

Well-fitted LABORATORIES can be used for Research at any hour convenient to Workers. Dark Room for Photographic and other Work. Workshop for making Apparatus. Electric Mains for Experiments.—"T.," 9 Heathcote Street, Gray's Inn Road, W.C.

KING'S COLLEGE, LONDON.
STATE MEDICINE LABORATORIES.

The Council invite Applications for the Post of Senior Demonstrator.
For particulars apply to the SECRETARY.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1524, Vol. 59] THURSDAY, JANUARY 12, 1899. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1525, Vol. 59] THURSDAY, JANUARY 19, 1899. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1526, Vol. 59] THURSDAY, JANUARY 26, 1899. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1527, Vol. 59] THURSDAY, FEBRUARY 2, 1899. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1528, Vol. 59] THURSDAY, FEBRUARY 9, 1899. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1529, Vol. 59] THURSDAY, FEBRUARY 16, 1899. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

16339

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" *To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1530, Vol. 59] THURSDAY, FEBRUARY 23, 1899. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1531, Vol. 59] THURSDAY, MARCH 2, 1899. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

UNIVERSITY OF GLASGOW.

CHAIR OF PATHOLOGY.

The Curators of the Chair of Pathology of the University of Glasgow will, in the month of April, proceed to appoint a Professor to occupy the above Chair now vacant. The Professor will be required to enter on his duties on April 25, from which date the appointment will take effect.

The normal Salary of the Chair is fixed by Ordinance at £1100.

The Class Room and Laboratory are in connection with the Pathological Department in the Western Infirmary, from which material is supplied to Professor and Students.

Each Applicant should lodge with the undersigned, who will furnish any further information required, twenty copies of his Application and twenty copies of any Testimonials he may desire to submit, on or before March 24.

ALAN E. CLAPPERTON,
Secretary of the Glasgow University Court.

91 West Regent Street, Glasgow.

BOROUGH POLYTECHNIC INSTITUTE,

103 BOROUGH ROAD, S.E.

The Governors of the above Institute invite Applications for the Post of ASSISTANT in the CHEMISTRY DEPARTMENT. Salary, £120 per Annum. Candidates will be required to undertake the Teaching of Classes in the Technical Day School and in the Evening Department. Full particulars may be obtained from the Principal.

Applications, accompanied by not more than three recent Testimonials, should be sent in before March 6, addressed to

C. T. MILLIS, Principal, Education Department.

BLACKBURN MUNICIPAL TECHNICAL SCHOOL.

Applications are invited for the position of ASSISTANT in the PHYSICS and ELECTRICAL ENGINEERING DEPARTMENT of the above School.

The duties include Assistance in the Evening Classes during the ordinary Evening Session, and in the Physics work of a Day School of Science. Salary, £110.

Applications, with three Testimonials, should be sent in not later than March 13.

A. W. KING, Secretary.

THE YORKSHIRE COLLEGE, LEEDS.

DEPARTMENT OF AGRICULTURE.

An ASSISTANT-LECTURER and DEMONSTRATOR is required in this Department. A leading part of his duties will be to assist in the carrying out of Field Experiments under the direction of the Professor. Salary to commence at £150 a year. The position is one which may grow in importance as the Assistant gains experience in lecturing to classes in the College, and to farmers in the County. Applications, addressed to the Secretary of the Yorkshire College, Leeds, will be received up to March 13. They should be accompanied by copies of testimonials, which should be specific as to the Candidate's scientific and practical training. Further particulars may be obtained from the Secretary.

THE YORKSHIRE COLLEGE, LEEDS.

DEPARTMENT OF LEATHER INDUSTRIES.

Applications will be received up to March 16 for the appointment of ASSISTANT-LECTURER and DEMONSTRATOR in LEATHER INDUSTRIES. A sound training in Chemistry is essential; technical knowledge, although desirable, is not indispensable. Salary to commence at £150 a year. Further particulars may be obtained from the Secretary of the College.

WANTED.—CHIEF CHEMIST and

MANAGER of WORKS, by a leading London Firm of Manufacturing Chemists employing several hundred people. The qualifications necessary for the position are high and well-grounded scientific knowledge and attainments; good practical experience in carrying out manufacturing processes; exceptional powers of organisation and administration; tact; good judgment; capability to direct and control scientific workers engaged in the manufacture of fine medicinal chemicals and pharmaceutical products. A gentleman with University training and Degrees preferred. The position commands a liberal salary. Replies will be treated in the strictest confidence if so desired. —Address, stating age, qualifications, and experience, to "Manager," c/o Messrs. Markby, Stewart, & Co., 57 Coleman Street, London.

WANTED, an ANALYTICAL CHEMIST

of exceptionally high and proved ability and accuracy, with good experience in testing Medical Chemicals, to take the position of Chief Analyst at the Works of a leading London Firm of Manufacturing Chemists. A gentleman who has taken University Degrees preferred. —Address, stating age, qualifications, and experience, to "Analyst," c/o Messrs. Markby, Stewart, & Co., 57 Coleman Street, London, E.C.

GUY'S HOSPITAL.

ENTRANCE SCHOLARSHIPS IN SEPTEMBER 1899.

Six Open Scholarships, three (£150, £60, and £50) in Science, and three (£100, £50, and £30) in Arts. Particulars, and copies of Examination Papers, on application to the Dean, Guy's Hospital, London Bridge, S.E.

GUY'S HOSPITAL.

PRELIMINARY SCIENTIFIC (M.B. Lond.) CLASSES are held throughout the year. Special Instruction is given for the July Examination. Fee, 16 Guineas.

BOTANY B.Sc. and Inter. Sc. Hons.

A Special Course starts next month. For full particulars apply to R. C. B. Kerin, B.A., Carlyon College, 55 Chancery Lane. (Classes for all London University Examinations.)

Sales by Auction.

MONDAY NEXT. CURIOSITIES.

MR. J. C. STEVENS will Sell by Auction at his Great Rooms, 38 King Street, Covent Garden, as above, at 12.30 precisely, several valuable Bronzes and other Curios taken at the capture of Benin City. An important and interesting Collection of New Guinea Curiosities. Coins, China, Carvings, Relics, Ancient Implements, Antiquities, &c.

On view Saturday prior 12–4, and Morning of Sale, and Catalogues had.

MONDAY, MARCH 13.

A COLLECTION OF EXOTIC LEPIDOPTERA AND OTHER NATURAL HISTORY SPECIMENS.

MR. J. C. STEVENS will Sell the above by Auction at his Great Rooms, 38 King Street, Covent Garden, as above, at 12.30 precisely.

THE ROYAL COLLEGE OF PHYSICIANS OF LONDON AND THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

CONJOINT LABORATORIES.

Notice is hereby given that the Appointment of Director of the Conjoint Laboratories will shortly be vacant. Candidates for the Appointment are now invited to transmit to the Secretary, on or before Wednesday, March 15th, their applications, accompanied by a statement of their qualifications for the post.

Particulars relating to the Salary and to the duties of the Appointment, may be obtained on application to the Secretary, Examination Hall, Victoria Embankment, London, W.C.

FREDERIC G. HALLETT, Secretary

March 1st, 1899.

QUERNMORE. LONDON BRANCH at 24 CHANCERY LANE, W.C.

Tuition by JOHN GIBSON, M.A. (First Class, Camb.), and G. LOLY, B.A. (First Class, London), for all Public Examinations. **Special Instruction in Scientific Agriculture** for successful practical Agriculture and Forestry in the British Islands or the Colonies; also in Geology, Botany, &c., Practical, Chemical, and Physical Laboratories. The "State Correspondent" and Higher Examination Journal gives up-to-date particulars of all the leading C.S. and other Examinations. Price 2½d., post free. Prize of One Guinea for competition each month; Special Prize of **Five Guineas** each June and December

INSTRUCTION IN PURE CULTIVATION OF YEAST,

According to **HANSEN'S Methods**.

Courses for Beginners, as well as for Advanced Students, in Physiology and Technology of Fermentations—Biological Analysis of Yeast.

Manuals:—E. Chr. Hansen: "Practical Studies in Fermentation." London (Spon), 1896. Alfred Jörgensen: "Micro-organisms and Fermentation." London (F. W. Lyon), 1893.

Further Particulars on Application to the Director, Alfred Jörgensen, The Laboratory, Copenhagen, V.

RESEARCH.

CHEMISTRY and PHYSICS.

Well-fitted LABORATORIES can be used for Research at any hour convenient to Workers. Dark Room for Photographic and other Work. Workshop for making Apparatus. Electric Mains for Experiments.— "T.," 9 Heathcote Street, Gray's Inn Road, W.C.

FOR SALE.—FAUNA UND FLORA

DES GOLFES VON NEAPEL. The Series of Monographs complete from the beginning. For particulars, apply Hurst, The Grange, Tadcaster, Yorkshire, England.

COACHING.

CHEMISTRY, PHYSICS, BIOLOGY.

All Examinations—Conjoint Board, University of London, D. P. H., &c., Theoretical and Practical. Small Classes or Private Tuition. Well-fitted Laboratories. Practical Forensic Medicine.—"R. C.," 9 Heathcote Street, Gray's Inn Road, London, W.C.

MEMORY

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THE SCHOOL OF MEMORY TRAINING,

70 Berners St., Oxford St., London, W.

SCIENTIFIC DEVELOPMENT OF THE NATURAL MEMORY.

The late Rd. A. Proctor (Editor of *Knowledge*) said: "I have no hesitation in thoroughly recommending the system."

Success at Exams. Mind Wandering Cured. Speaking without Notes. How to successfully study all Branches of Science, Mathematics, Classics, &c. Prospectus post free on application to the Secretary

NATURE

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Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1532, Vol. 59] . THURSDAY, MARCH 9, 1899. [Price Sixpence

UNIVERSITY OF LONDON.

NOTICE IS HEREBY GIVEN, that on WEDNESDAY, 26th of APRIL next, the Senate will proceed to elect Examiners in the following Departments for the year commencing July 1, 1899:—

Examinerships.	*Salaries.* (*Each.*) £	*Present Examiners.*
ARTS AND SCIENCE.		
Two in Latin ...	180	Prof. J. P. Postgate, M.A., Litt.D. Vacant.
Two in Greek ...	120	G. E. Marindin, Esq., M.A. Prof. R. Y. Tyrrell, Litt.D., D.C.L.
Two in the English Language and Literature	150	Prof. J. W. Hales, M.A. Vacant.
Two in History ...	100	S. R. Gardiner, Esq., D.C.L. Prof. F. York Powell, M.A.
Two in the French Language and Literature	130	James Boielle, Esq., B.A. Vacant.
Two in the German Language and Literature	80	E. L. Milner-Barry, Esq., M.A. A. W. Schüddekopf, Ph.D., M.A.
Two in the Hebrew Text of the Old Testament, the Greek Text of the New Testament, the Evidences of the Christian Religion, and Scripture History...	50	Rev. C. F. Burney, M.A. J. F. Stenning, Esq., M.A.
Two in Mental and Moral Science	120	Prof. S. Alexander, M.A. Vacant.
Two in Political Economy ...	60	Prof. C. F. Bastable, M.A. Prof. W. A. S. Hewins, M.A.
Two in The Art, Theory, and History of Teaching ...	25	Prof. James Sully, M.A., LL.D. Vacant.
Two in Mathematics and Natural Philosophy ...	200	E. W. Hobson, Esq., Sc.D., M.A., F.R.S. Joseph Larmor, Esq., D.Sc., M.A. F.R.S.
Two in Experimental Philosophy	210	Prof. G. F. FitzGerald, M.A., F.R.S. Prof. Silvanus Thompson, D.Sc., B.A., F.R.S.
Two in Chemistry	240	Prof. William Ramsay, Ph.D., LL.D., F.R.S. Vacant.
Two in Botany and Vegetable Physiology	135	Prof. F. W. Oliver, M.A., D.Sc. Prof. J. W. H. Trail, A.M., M.D., C.M.
Two in Comparative Anatomy and Zoology	120	F. E. Beddard, Esq., M.A., F.R.S. Prof. G. B. Howes, LL.D., F.R.S.
Two in Geology and Physical Geography	75	Prof. T. G. Bonney, Sc.D., M.A., F.R.S. Prof. Charles Lapworth, LL.D., F.R.S.
LAWS.		
Two in Jurisprudence, Roman Law, Principles of Legislation, and International Law	100	J. B. Moyle, Esq., D.C.L. Vacant.
Two in Equity and Real and Personal Property ...	50	E. J. Elgood, Esq., B.C.L., M.A. T. Cyprian Williams, Esq., LL.B.
Two in Common Law and Law and Principles of Evidence	50	Hugh Fraser, Esq., M.A., LL.D. Vacant.
Two in Constitutional History of England	[illegible]	S. H. Leonard, Esq., M.A., B.C.L. Prof. F. C. Montague, M.A.
MEDICINE.		
Two in Medicine	210	W. H. Allchin, Esq., M.D. Frederick Taylor, Esq., M.D.
Two in Surgery	200	William Anderson, Esq., F.R.C.S. W. Watson Cheyne, Esq., M.B., C.M., F.R.C.S.
Two in Anatomy	150	Prof. G. D. Thane. Prof. A. H. Young, M.B.
Two in Physiology	140	Prof. J. G. McKendrick, M.D., F.R.S. Prof. E. A. Schäfer, LL.D., F.R.S.
Two in Obstetric Medicine ...	105	Peter Horrocks, Esq., M.D. Vacant.
Two in Materia Medica and Pharmaceutical Chemistry	100	D. J. Leech, Esq., M.D. Sidney Phillips, Esq., M.D.
Two in Forensic Medicine	80	Prof. J. Dixon Mann, M.D. Thomas Stevenson, Esq., M.D.
Two in State Medicine	30	Arthur Newsholme, Esq., M.D. Edward Seaton, Esq., M.D.
Two in Mental Physiology .	25	Prof. S. Alexander, M.A. T. Claye Shaw, Esq., M.D., B.A.
MUSIC.		
Two in Music	50	C. H. Lloyd, Esq., Mus.Doc. Sir Walter Parratt, Mus.Doc.

The Examiners above named are re-eligible, and intend to offer themselves for re-election.

Candidates must send in their names to the Registrar, with any attestation of their qualifications they may think desirable, on or before TUESDAY, MARCH 28. (It is particularly desired by the Senate that no application of any kind be made to its individual Members.)

University of London,
Burlington Gardens, W.,
March 1, 1899.

By order of the Senate,
F. VICTOR DICKINS, M.B., B.Sc.,
Registrar.

BIRKBECK INSTITUTION,

Breams Buildings, Chancery Lane, E.C.

PRINCIPAL: G. ARMITAGE-SMITH, M.A.

DAY AND EVENING CLASSES.

UNIVERSITY OF LONDON.—Complete Day Courses for all the Examinations in Science, and Complete Evening Courses for all the Examinations for the Science, Arts, and Law Degrees.

SCIENCE CLASSES in every Branch, with Practical Work. Well equipped Laboratories for Chemistry, Physics, Biology, Botany, Geology, Mineralogy, and Metallurgy.

CONJOINT BOARD: Lectures and Practical Work in Chemistry, Physics, Biology, and Practical Pharmacy. NEW TERM for Conjoint Board and Inter. M.B. Examinations has just commenced.

Prospectus, Calendar (6d.), and Syllabuses of Classes on application to the Secretary.

THE ROYAL COLLEGE OF PHYSICIANS OF LONDON AND THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

CONJOINT LABORATORIES.

Notice is hereby given that the Appointment of Director of the Conjoint Laboratories will shortly be vacant. Candidates for the Appointment are now invited to transmit to the Secretary, on or before Wednesday, March 15th, their applications, accompanied by a statement of their qualifications for the post.

Particulars relating to the Salary and to the duties of the Appointment, may be obtained on application to the SECRETARY, Examination Hall, Victoria Embankment, London, W.C.

FREDERIC G. HALLETT, Secretary.

March 1st, 1899.

UNIVERSITY OF EDINBURGH.

CHAIR OF PHYSIOLOGY.

The Curators of Patronage of the University of Edinburgh will, on a date to be afterwards fixed, proceed to the election of a PROFESSOR of PHYSIOLOGY in room of the late Prof. RUTHERFORD.

Each Candidate for the Chair is requested to lodge with the undersigned, not later than Saturday, May 20 next, Eight copies of his Application and Eight copies of any Testimonials which he may desire to submit. One copy of the Application should be signed.

R. HERBERT JOHNSTON, W.S., Secretary.

66 Frederick Street, Edinburgh, March 6, 1899.

THE YORKSHIRE COLLEGE, LEEDS.

DEPARTMENT OF AGRICULTURE.

An ASSISTANT-LECTURER and DEMONSTRATOR is required in this Department. A leading part of his duties will be to assist in the carrying out of Field Experiments under the direction of the Professor. Salary to commence at £150 a year. The position is one which may grow in importance as the Assistant gains experience in lecturing to classes in the College, and to farmers in the County. Applications, addressed to the SECRETARY of the Yorkshire College, Leeds, will be received up to March 13. They should be accompanied by copies of testimonials, which should be specific as to the Candidate's scientific and practical training. Further particulars may be obtained from the SECRETARY.

THE YORKSHIRE COLLEGE, LEEDS.

DEPARTMENT OF LEATHER INDUSTRIES.

Applications will be received up to March 16 for the appointment of ASSISTANT-LECTURER and DEMONSTRATOR in LEATHER INDUSTRIES. A sound training in Chemistry is essential; technical knowledge, although desirable, is not indispensable. Salary to commence at £150 a year. Further particulars may be obtained from the SECRETARY of the College.

BRUNTS TECHNICAL SCHOOL, MANSFIELD.

An ASSISTANT MASTER is Wanted in the above School of Science, to teach Woodwork and able to assist in the Chemical or Physical Laboratory. Salary, £90 to £100 per Annum.

Apply, giving qualification, age, experience and references, to

C. E. STACEY, B.A., B.Sc.

COACHING.

CHEMISTRY, PHYSICS, BIOLOGY.

All Examinations Conjoint Board, University of London, D. P. H., &c., Theoretical and Practical. Small Classes or Private Tuition. Well-fitted Laboratories. Practical Forensic Medicine.—"R. C.," 9 Heathcote Street, Gray's Inn Road, London, W.C.

For other Advertisements of the foregoing character, see page clii.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1533, Vol. 59] THURSDAY, MARCH 16, 1899. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
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No. 1534, Vol. 59] THURSDAY, MARCH 23, 1899. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
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No. 1535, Vol. 59] THURSDAY, MARCH 30, 1899. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1536, Vol. 59] THURSDAY, APRIL 6, 1899. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1537, Vol. 59] THURSDAY, APRIL 13, 1899. [Price Sixpence

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1538, VOL. 59] THURSDAY, APRIL 20, 1899. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1539, Vol. 59] THURSDAY, APRIL 27, 1899. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]